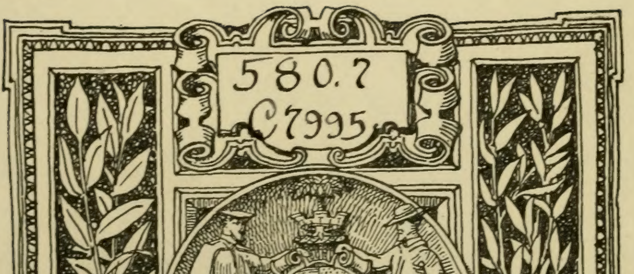

580.7
C7995
PRO SCIENTIA
SALUTE
POPULIQUE
LIBRARY OF
THE NEW YORK BOTANICAL GARDEN
By exchange
1930-32
Septemb 1897
R. W. Gibson. Inv.

Arbejder fra den
botaniske Have i København. Nr. 115.

PHYLLOPHORA BRODIÆI AND ACTINOCOCCUS SUBCUTANEUS

BY

L. KOLDERUP ROSENVINGE

WITH ONE PLATE

Særtryk af Det Kgl. Danske Videnskabernes Selskab
Biologiske Meddelelser VIII, 4.

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1929

Arbejder fra den
botaniske Have i København. Nr. 115.

PHYLLOPHORA BRODIÆI AND ACTINOCOCCUS SUBCUTANEUS

BY

L. KOLDERUP ROSENVINGE

WITH ONE PLATE

Særtryk af Det Kgl. Danske Videnskabernes Selskab
Biologiske Meddelelser VIII, 4.

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI
1929

I. Historical Account.

The reproduction of *Phyllophora Brodiæi* (Turn.) J. Agardh has been much disputed for more than a century. Everywhere within the area of this Subarctic-North-Atlantic species globular bodies of various sizes, up to 3,5 mm. in diameter, have been found sessile on the upper border of the frond or on particular small shoots. TURNER who first described it in 1809 (Turner 1809, plate 72) as a species different from *Ph. membranifolia* stated that the small spherical tubercles were composed of "jointed parallel, fibres, closely matted together, and mixed with irregularly rounded seeds". LYNGBYE (1819, p. 11) was much in doubt as to whether these tubercles were really the fructification of the alga; he did not succeed in finding the seeds described by TURNER and stated that he had earlier described and pictured these fruits in ms. under the name of *Chætophora membranifolii*, thinking that it was some parasite growing on *Ph. membranifolia* and so giving it the character of *Ph. Brodiæi.* On the authority of TURNER, however, he maintains the latter species. In 1834 LYNGBYE took up again more positively the hypothesis of parasitism of the tubercles, giving in Flora Danica tab. $2135,_2$ a picture of the filaments composing the tubercles with the text here reproduced: *Chætophora subcutanea* Lyngb. Mnscr.: cespite roseo, filis, stellatim radiatis, simplicibus et ramosis moniliformibus. — *Chæto-*

phora membranifolii Lyngb. l. c. p. 11 t. 3 B f. 3. — The alteration of the specific name is certainly due to the fact that Lyngbye now considered *Ph. Brodiæi* a well characterized species, and the specific name alluded to the fact that the radiating filaments are covered by a distinct cuticle. Greville (Alg. Brit. 1830, p. 133) pointed out that the joints ("granules") of the filaments are "made up of three or four smaller ones", from which it may be concluded that he saw the formation of tetrasporangia in the filaments. The hypothesis of the parasitism of these bodies was taken up by Suhr; he sent them, under the name of *Rivularia rosea*, to Kützing, who described and pictured them in 1843 (Phyc. gen. p. 177, Taf. 45. Fig. IV, 1, 2) under the name of *Actinococcus roseus* with the following diagnosis: A. marinus, parasiticus roseus; cellulis hinc inde quadripartitis. In der Ostsee an Coccotylus Brodiaei und anderen Algen: v. Suhr. Kützing seems, however, to have no idea of the identity of this supposed parasite with the "sirothelia exacte sphaerica, laevia petiolata" described in the same work p. 412 as the fructification of *Coccotylus Brodiæi*. Fig. 2 shows the cells divided into four, but the orientation of the cells in the tetrads is very variable and not in accordance with reality. J. Agardh (Sp. g. o. Alg. II, 1, p. 330, 1851) describes the nemathecia, as these bodies were named by C. Agardh (Spec. Alg. Vol. I, 1822, p. 228), and states that the joints of the radiating filaments develop into tetrasporangia (sphærosporæ) which are cruciately divided, but he maintains that the plant has also "kalidia" (cystocarps) which are said to resemble the nemathecia very much. The existence of such nemathecia-like cystocarps has, however, never been confirmed.

The question of the nature of the nemathecial bodies was first taken up for thorough examination by FR. SCHMITZ in a paper on the genus *Actinococcus* (1893). He had worked at the question for several years and had reached the conclusion that *Actinococcus roseus* must be considered as a parasite growing on *Phyllophora Brodiæi*, a view he expressed already in 1899 in the survey he published of the hitherto known genera of Florideæ (Flora 1889), and this view was adopted by REINKE in his Algenflora der westl. Ostsee published in the same year. SCHMITZ found that the medullary cells of *Phyllophora* in the interior of the nemathecial fruit are separated more or less from each other and the interstices filled up with a complex of smaller cells forming branched rows of cells. In the outer cortex, these filaments continue as the radiating filaments in the nemathecial wart where they later form the seriate tetrasporangia. But with these fertile filaments, groups of short cortical filaments originating from the sterile frond are frequently intermixed, in particular in young nemathecial warts. When two such warts of different ages are to be found on the opposite faces of the same segment of the frond, as will frequently happen, the filaments constituting the one wart can be followed into the interior of the fertile section of the frond and from thence to the opposite nemathecial wart. Moreover, several quite young warts may fuse together to form one nemathecial wart. In quite young warts the "fertile" cells do not become connected through pits with the cells of the sterile tissue. Such a connection seems only to be established with certain cells which then become larger and rich in protoplasm. The alleged facts could, in SCHMITZ's opinion, only be explained by the supposition that there are two different organisms, a host plant and

a parasite. The origin of the latter was not, however, explained. The name *Actinococcus* is then given to the parasite that comprises not only the nemathecial bodies but also the intramatrical filaments. At the end of Schmitz's paper the parasite is given the name of *Actinococcus subcutaneus* (Lyngb.) Rosenv.[1]

Schmitz's discoveries were tested by the French algologist Gomont who convinced himself of the accuracy of Schmitz's observations by an anatomical investigation of material in the Muséum d'histoire naturelle in Paris. On the other hand, Reinke became doubtful as to the correctness of the independence of "*Actinococcus roseus*", which was no doubt connected with the fact that O. V. Darbishire, then assistant at the Botanical Institute at Kiel, was working at the question. In a preliminary note (1894) and a very valuable monograph of the *Phyllophora* species in the western Baltic (1895) Darbishire described the structure and development of the organs of reproduction and as to the nemathecia arrived at a view opposite to that of Schmitz. He gave a careful description of the antheridia which arise in crypts sunk in the cortical layer of particular small shoots, "spermophores" at the upper end of the flat fronds. He further described the female shoots that, when young, much resemble the spermophores and like these are placed at the upper end of the frond (comp. fig. 47 I), whereas the older carpophores are said to be placed like those of *Ph. membranifolia* at the borders of the flat frond and have much the same appearance as those of this species. He found procarps, not before observed, in the young female shoots, and imagined that these shoots

[1] Lyngbye's specific name of 1834 remained unnoticed till I called attention to it (1893, p. 822).

grow out into flat leaves on the borders of which the cystocarps arise, much as in *Ph. membranifolia*. If this were correct, the origin of the carpophores would be very different from that in *Ph. membranifolia* where the carpophores arise on the border of the older segments of the frond and the procarps arise in their interior some time after their formation.

As I have never seen specimens of *Ph. Brodiæi* with cystocarps in the Danish waters, and such specimens have not been mentioned by other authors, it was of interest to me to see the specimens on which Darbishire has founded his statement of the presence of lateral carpophores and cystocarps in this species. Through the kind assistance of Dr. Curt Hoffmann I have been able to examine the cystocarp-bearing specimens collected by Kuckuck at Kiel in 1891, referred to *Ph. Brodiæi* and mentioned by Darbishire (l. c. p. 32); they turned out to be female specimens of *Ph. membranifolia* erroneously referred to *Ph. Brodiæi*; they belong to the narrow form of the former species, common in the inner Danish waters. I have no doubt but that a similar mistake has taken place with the large "typical" plants with well developed lateral carpophores containing a cystocarp mentioned by Darbishire as found at Helgoland. At any rate I cannot see why the plant pictured in fig. 46 (l. c. p. 32) should necessarily be referred to *Ph. Brodiæi* and not to *Ph. membranifolia*. Until better evidence is forthcoming it must be taken for granted that cystocarps have never been ascertained in *Phyllophora Brodiæi*.

The nemathecia, according to Darbishire, arise in the first months of the year in the interior of the small fertile shoots, near their apex, single cells in the inner cortex

producing from their surface cells that grow out into cell-filaments forming a particular tissue in the inner part of the leaflet, which causes a swelling of the latter; the peripherical filaments may force their way through the cortex and form a nemathecium. The author confirms the statement of Schmitz that the filaments may grow out onto the opposite face of the leaflet and form a new or several new nemathecial cushions. Further Darbishire made the important observation that the tetraspores from the nemathecia that ripen in winter are able to germinate in cultures independently of any host-plant, forming deep red cell-filaments and cell-discs or cushions that he thinks would under better conditions develop into basal discs of *Phyllophora Brodiæi*. Darbishire concludes from his observations that the nemathecia in *Ph. Brodiæi* are the true and only organs that produce tetrasporangia in this species.

Unfortunately Schmitz was prevented from further investigation of this problem, as he died after a short illness in January 1895.

Darbishire's conception of *Actinococcus* as an organ belonging to *Phyllophora Brodiæi* was accepted in my second paper on the marine Algæ of Greenland (1898, p. 33), while I had followed Schmitz in 1893 (p. 822). I now relied on my own observations too, having never in the Danish or the Greenland waters met with cystocarp-bearing individuals of *Phyllophora Brodiæi*. Schmitz's view would lead to the absurd conclusion that this species does not possess any kind of spores.

In the following years Darbishire pursued his investigations on this subject at Kiel and published a new paper in 1899, On *Actinococcus* and *Phyllophora*, in which, strange to say, he accepted the view of Schmitz. Darbishire

had observed that the antheridial cavities of *Phyllophora Brodiæi* often accompanied the presence of *Actinococcus subcutaneus*, and after a close investigation of this coincidence he made out that it was possible to explain it by supposing that *Actinococcus* is a parasite that "only can enter the host when the male (or the female?) organs of the latter are present". He thought that he had observed the entrance of *Actinococcus* by the small ostioles of the antheridial cavities. "The immediate product of germination seems to be a small heap of perhaps 4—8 cells, one of which always comes to be near an ostiole leading to an antheridial cavity. . . . A filament is then formed, which passes into the host-plant through the antheridial ostiole (Plate XV, Fig. 1)". However, the figure quoted gives no evidence of the correctness of the given interpretation. An antheridial cavity seems to be faintly seen under a bunch of filaments, but it is situated at a lower level than the normal antheridial cavities, and it can by no means be taken for granted that the filament has entered the host at this place; it would be equally probable that the small heap of cells on the surface of the *Phyllophora* had been produced by a filament forcing its way outwards through the cortex, perhaps through an antheridial cavity, and that it was on the way to forming a nemathecium. Darbishire maintains that the presumed parasite "is unable to pierce the outer covering of the host, when entering the latter. It can only attack the latter through the antheridial ostioles". He thinks, however, that *Actinococcus* may also be able to enter the host by means of the opening caused by the projecting trichogyne, as he has "seen *Actinococcus*-bearing shoots of *Phyllophora*, in the cortical layers of which could be seen what were apparently remains of undeveloped carpogones"

(l. c. p. 258). This latter remark is of interest, as it refers to an important fact which will be mentioned later, but it has a quite different meaning to that suggested by the author. Darbishire adds that antheridia and procarps do not occur on the same plant, but this is not in accordance with my observations, as will be mentioned later. He supposes that the antheridia appear in the autumn and that the parasite then enters the host-plant through the ostioles. He imagines that "it is not unlikely that what we see germinating on *Phyll. Brodiæi* in the autumn is really a carpospore", (l. c. p. 263) produced by an unknown sexual generation. He finally relates that "In discussing the question a short time ago with Professor Reinke, the latter suggested as a possibility, which ought not to be dismissed prima facie, that *Actinococcus* might really be an asexual generation of *Phyll. Brodiaei*, growing parasitically on the sexual generation" (l. c. p. 264). But the author does not consider it very probable that this represents the true state of affairs, and he maintains the view that the nemathecia of *Phyll. Brodiæi* have not yet been found.

It will be seen that the problem is still very dubious after Darbishire's last paper. It has not been treated later on by researches or experiments, but R. W. Phillips has given a valuable critical survey of it in 1925. In citing Darbishire's reference to cystocarps in *Phyll. Brodiæi* he states that these organs have never yet, as far as he can ascertain, been collected in British waters. He further states, in accordance with Darbishire, that he has "seen what seemed to me to be derelict procarps . . . in the neighbourhood of the *Actinococcus* nemathecia" (1925, p. 252). Reinke's suggestion is mentioned; Phillips points out that the carposporophyte in diplobiontic Florideæ is always

parasitic on the gametophyte generation and asks whether it is impossible that in this case the tetrasporophyte is so also[1].

II. The Reproduction of Phyllophora membranifolia.

Before describing the development and the fate of the procarps of *Ph. Brodiæi* I shall briefly mention the reproduction of the related *Ph. membranifolia.* This species is a typical diplobiontic Floridea, having sexual and asexual

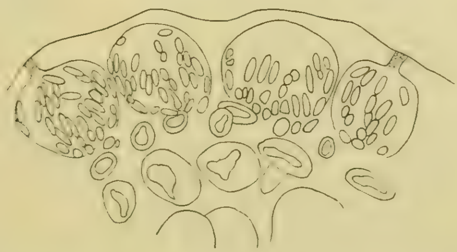


Fig. 1. *Phyllophora membranifolia.* Transverse section of androphore showing four antheridial crypts. 625 : 1.

individuals. The first are of two distinct kinds, male and female. The male individuals produce the antheridia in particular yellowish or nearly colourless, up to 2 mm long, folioles borne on the upper border of the flat fronds. The antheridia, as shown by Darbishire (1895, p. 30), arise in small globular crypts sunk in the outer cortical layer of the spermophores and provided with an orifice in the roof (fig. 1). — The procarps arise in the cortical layer of particular oblong or nearly globular short-stalked carpophores borne on the upper part of the cylindrical and the

[1] H. Printz (1926, p. 60) has mentioned some specimens of *Phyllophora Brodiæi* collected in August at Trondhjem with young nemathecia not identical with the nemathecia of *Actinococcus.* Upon enquiry Prof. Printz has kindly answered me that he is not now able to give any information about this observation which was made many years ago, and that he has not access now to the specimens in question.

lower part of the flat thallus of the female plants. The carpogonial branch is three-celled, borne on a large bearing

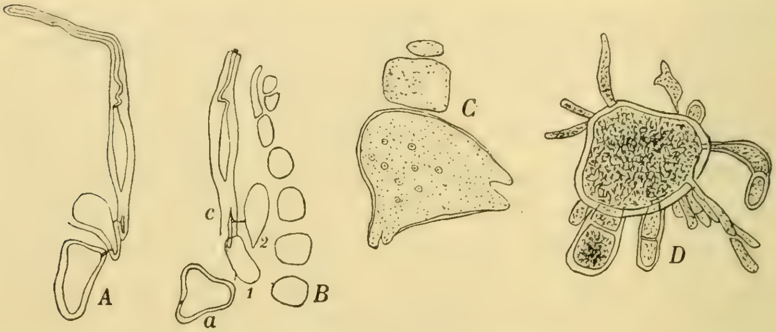


Fig. 2. *Phyllophora membranifolia.* *A*, carpogonial branch. *B*, procarp. *a*, auxiliary cell, *1*, *2*, *c* carpogonial branch. *C*, the auxiliary cell is plurinuclear. *D*, auxiliary cell pushing out numerous gonimoblast filaments. *A* 625 : 1. *B—D* 390 : 1.

cell that becomes an auxiliary cell. The carpogonium has a prolongation downwards which is laterally inserted by a pit on the second cell of the carpogonial branch (fig. 2 *A*, *B*). A spermatium seems to have been attached to the trichogyne in fig. 2 *A*. The fertilization and the transfer of the sporogenous nucleus to the auxiliary cell have not been observed, but the development of the latter is shown in fig. 2, *C*, *D*. While at first it contains one nucleus, it becomes plurinuclear and pushes out prolongations, first from the under side, later from all sides, which develop into

Fig. 3. *Phyllophora membranifolia.* Portion of transverse section of ripe cystocarp. November. 390 : 1.

gonimoblast filaments, becoming septate and branched. These gonimoblast filaments penetrate into the medullary tissue of cells rich in starch and produce numerous small carpospores. In the ripe cystocarp cell filaments originating from the medullary tissue are seen traversing the mass of carpospores (fig. 3). — The nemathecia arise in summer as deep-red wedge-shaped spots on both faces of the lower part of the flat frond. They are built up of parallel filaments of cells which develop into tetrasporangia with the exception of the outermost cells. The division of the sporangia takes place in winter (comp. DARBISHIRE 1895, p. 27); they are first divided by a transversal wall, later by two vertical ones.

III. The Sexual Organs of Phyllophora Brodiæi.

The principal points to be investigated when treating of the much disputed but still unsolved problem of the reproduction of this species were: 1) the first origin of the nemathecium-forming filaments, 2) the possible connection between the latter and the sexual organs of *Phyllophora Brodiæi* and 3) the fate of the germinating tetraspores. The sexual organs will first be mentioned.

DARBISHIRE maintains that *Phyll. Brodiæi* is dioecious (1899, p. 258), but that does not agree with my observations. Antheridia and procarps arise in particular sexual leaflets situated on the upper border of the flat fronds (fig. 5) or in the upper margin of the young segment of broad fronds (fig. 6). In both cases the two sexes usually occur in the same plant and often in the same organ, leaflet or margin. When the upper marginal zone of a frond becomes fertile, it increases considerably in a transverse direction and therefore becomes undulated (fig. 6),

and it also increases in thickness. The small fertile shoots (fig. 5 *B*) are usually more or less flattened, but sometimes nearly terete or angulate; in the former case they may be canaliculate. Darbishire (1895, fig. 38 and 47) has figured them and mentioned them as spermophores and female shoots respectively, and it may happen that they contain only antheridia or procarps, but usually they contain both sexes though often in very different quantities,

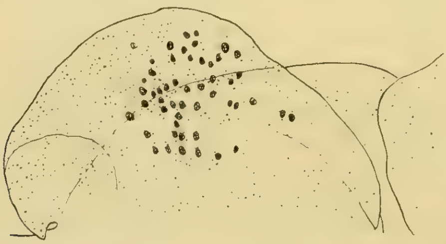


Fig. 4. *Phyllophora Brodiæi*. Fertile lobe of frond with a group of procarps made distinct by staining with hæmatoxyline. 47 : 1.

and sterile leaflets also occur. On cutting a number of leaflets by microtome one may convince oneself of the irregularity of the distribution of the sexual organs, and the same is the case with the fertile border of the broad fronds. In fig. 4 is shown a lobe of an undulated margin of a frond containing numerous procarps while most of the other lobes of the same frond were without procarps.

The antheridia are similar to those of *Phyll. membranifolia*. As shown by Darbishire (1895, p. 29, fig. 38—39, 1899, p. 257) they are developed in small flask-shaped or nearly globular cavities situated just within the surface of the sexual shoot and, when ripe, communicating with the exterior by a small ostiole (comp. fig. 7). Each cavity derives from one superficial cell. The crypts contain a number of converging filaments consisting of 3 or 4 cells

Fig. 5. *Phyllophora Brodiæi*. *A*, from a dredging south of Als in June, 8,5 m. depth, nemathecia in leaflets, terminal or marginal. *B*, from 12 metres' depth off Ballen, Samø in August; with nemathecia and new sexual leaflets. 1,8 : 1.

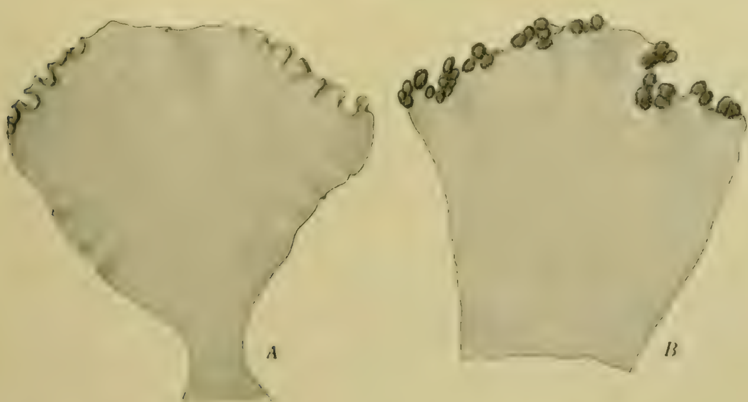


Fig. 6. *Phyllophora Brodiæi*. Lille Belt, 18—19 metres' depth, June. *A*, upper end of frond with undulated fertile margin. *B*, similar with young nemathecia. c. 5 : 1.

which produce the spermatia in descending sequence. DARBISHIRE calls each filament an antheridium (1895, p. 29). These cavities may form a continuous layer or they appear singly (fig. 7) and then project more or less over the surface. The antheridia were met with in the months of March and May to November. They are not restricted to the autumn, as supposed by DARBISHIRE.

For the examination of the procarps the material was in several cases treated with FLEMMING's weaker solution,

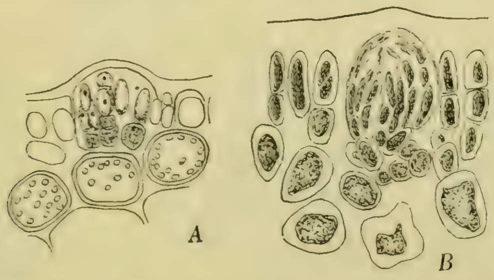


Fig. 7. *Phyllophora Brodiæi.* Two antheridial crypts. *A*, not fully developed. *B*, ripe, August. 625 : 1.

imbedded in paraffine and the microtomed sections stained a. m. HEIDENHAIN, but this method has the inconvenience that the sections are very liable to loosen from the slide owing to the great swelling power of the intercellular substance (SCHMITZ's 'collode') in water, so that most of the sections were lost in many cases. To avoid this, the sections were stained with hæmatoxyline (MAYER's hæmalum or HANSEN's hæmatoxyline), or the sexual shoots were cut with the freezing microtome and stained with the same reagents. Other fixing media used were: formaline-sublimate, Nawashin's treatment[1], and further formaline alone or 70—80 per cent alcohol. And finally, Dr. HENNING

[1] See J. CLAUSEN, Chromosome number and the relationship of species in the genus Viola. Annals of Botany, Vol. XLI. Oct. 1927, p. 678.

E. Petersen has kindly left at my disposal a valuable material from Ellekilde Hage in the Øresund, fixed by him with Juel's solution, June 30th 1910.

The procarps are situated in the inner cortex. When fully developed they are composed of a tricellular carpogonial branch and a large bearing cell which becomes an auxiliary cell, but it may happen that two carpogonial bran-

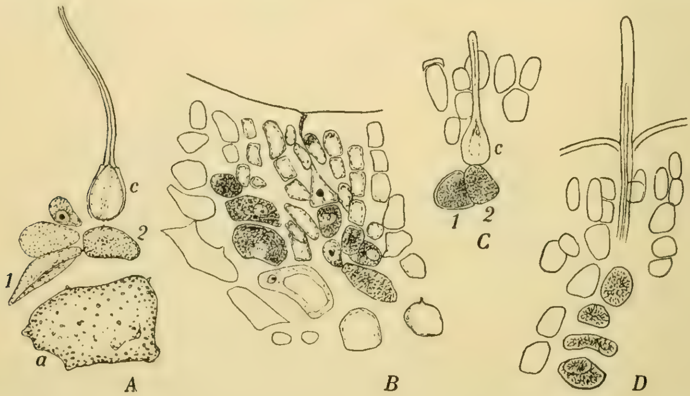


Fig. 8. *Phyllophora Brodiæi*, from Lille Belt, east of Hesteskoen, June 1922, frond with crenulated border. *A*, procarp; a two-celled branch issues from the first cell of the carpogonial branch; *a*, the auxiliary cell, *1*, *2*, *c*, the cells of the carpogonial branch. *B*, two procarps, that to the left without trichogyne. *C*, carpogonial branch isolated by pressure. *D*, protruding trichogyne, the base of which cannot be distinguished. 560 : 1.

ches are borne on the same bearing cell (fig. 10 *D*). Darbishire figures a young procarp with a short trichogyne projecting a little over the surface (1895, p. 33); he considers the bearing cell as the lowermost cell of the carpogonial branch which is therefore said to be four-celled. (Comp. above p. 6).

The procarps were examined in several specimens from various localities and at different seasons. They showed considerable differences so the particular specimens will

be treated separately. It must first be mentioned that the great majority of the procarps observed were incompletely developed. These organs are easily recognizable by their staining power with hæmatoxyline (Heidenhain, Hansen's and Mayer's hæmalum) and their abundant protoplasmic contents, and the bearing cell, too, by its great size. The latter is always present, but the carpogonial branches are often more or less defective. Even when they are normally tricellular, the outmost cell is most frequently not developed as a normal carpogonium but roundish like the other cells of the branch (fig. 8 *B* to the left, 10 *B—D*, 11 *C*). A two-celled branch is shown in fig. 9. The best developed carpogonial branches were met with in May and June, when long, projecting trichogynes were often observed. That pictured in fig. 8 *A* shows the pit-connections between the bearing cell and the carpogonial branch and between the cells of the latter. The carpogonium has a well developed trichogyne but the ventral part is inflated, only poorly provided with protoplasm, and contains no nucleus; it is evidently avorted. The same is the case with that shown in fig. 8 *C* where the trichogyne is short, scarcely projecting over the surface, and the contents still more faint. The carpogonium fig. *B* shows a nucleus, but the protoplasm is feebly developed and the trichogyne only discernible as a canal through the outer wall. In fig. *D* a well developed trichogyne is seen protruding far above the surface, but its lower part was not present in the section. The carpogonium

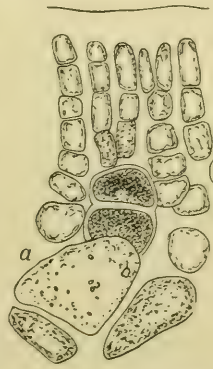


Fig. 9. *Phyllophora Brodiæi*, from the same specimen as fig. 8. Two-celled carpogonial branch. 560 : 1.

shown in fig. 10 *A* had a large nucleus situated near the lower end of the cell and was attenuated above into a

Fig. 10. *Phyllophora Brodiæi.* Collected by Dr. Henning Petersen at Ellekilde Hage, Øresund June 1910 and treated with Juel's solution. *A*, procarp; the carpogonium is attenuated toward the trichogyne channel but the trichogyne itself is wanting. *B*, the last cell has not the character of a carpogonium; the bearing cell seems to be uninuclear. *C*, similar, the bearing is plurinuclear. *D*, the bearing cell is multinuclear; it bears two carpogonial branches, but no carpogonium is developed. *E*, procarp showing more than the ordinary number of cells, without carpogonium. *F*, similar group to the left. *A*, *B*, 870 : 1. *C*—*F*, 480 : 1.

short thin thread, but the trichogyne itself was wanting, though the trichogyne channel was very distinct. In all these procarps, the carpogonium had a rounded or plane base.

In a specimen from Frederikshavn gathered in October I found carpogonial filaments of a different shape, having a carpogonium with oblique base (fig. 11 *A*). Still more aberrant is the carpogonial branch pictured in fig. 12 *A*. A small ovate cell is seen under the carpogonium, connected with it by a pit at its upper, pointed end and connected by a lateral pit with a larger cell which must be

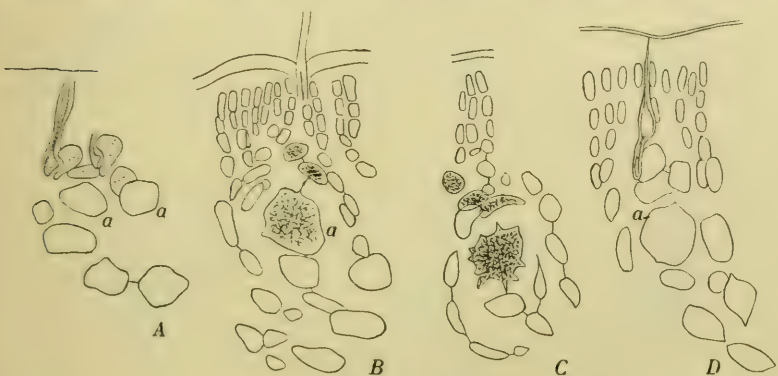


Fig. 11. *Phyllophora Brodiæi.* Specimen collected at Deget near Frederikshavn in October. *A*, two procarps with laterally inserted carpogonia. *B*, procarp; the carpogonium is not visible but a portion of the trichogyne is seen piercing the cuticle. *C*, the last cell of the carpogonium filament has not the character of a carpogonium, the bearing cell is stellate. *D*. The supposed carpogonium has produced a short septate, thin, downward growing filament. *A*, 560 : 1. *B—D*, 350 : 1.

supposed to be the first cell of the carpogonial branch, while the bearing cell is not to be seen. This branch shows some resemblance to the carpogonial branch of *Phyllophora membranifolia* if we compare the small cell with the prolongation downwards from the carpogonium in the latter species, but this prolongation is not separated by a transverse wall from the carpogonium. In other procarps from the same specimen I found a similar oblong smaller cell under the carpogonium. The procarp figured in fig.

12 *B*, met with in the same specimen, is better in accordance with *Phyll. membranifolia*; the lowermost flat cell must be the bearing cell. The fact that two different types of procarps, both different from that first described, are met

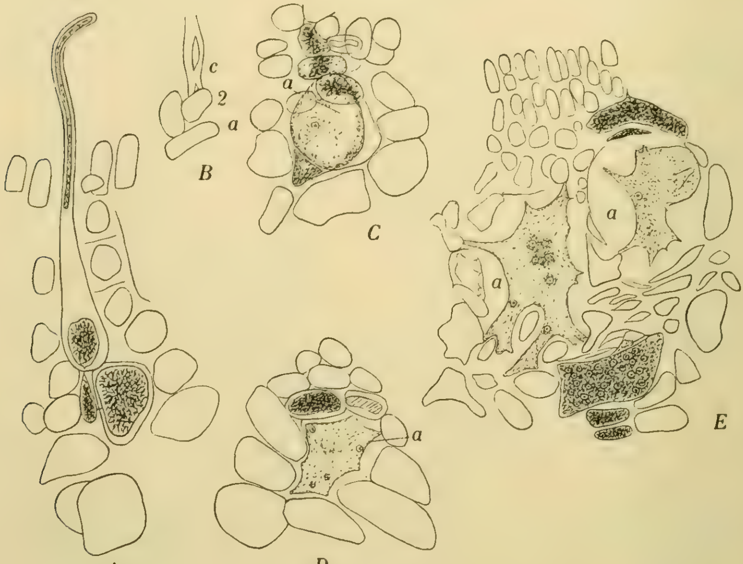


Fig. 12. *Phyllophora Brodiæi.* From a specimen collected in Store Belt in May, fixed with formol-sublimate. *A*. Three cells only are to be seen in the procarp; the bearing cell seemed to be wanting in the section. *B*, procarp the interpretation of which was doubtful; no transverse wall was visible at the narrowing of the carpogonium. *C*. At least two nuclei were present in the bearing cell that is still round. *D*. The bearing cell is angular, plurinuclear. *E*. Three bearing cells, the two showing numerous nuclei, two producing prolongations forcing their way between the surrounding cells. *A*, 1000 : 1. *B—E*, 560 : 1.

with, suggests that the procarps in this species are in a stage of degeneration. The first described type is perhaps the most reduced one, as it is most remote from that of *Phyll. membranifolia*.

In no case were spermatia found adhering to the tri-

chogynes and no other signs of a fertilization were observed. The case represented in fig. 11 *D* might suggest a transferring of a nucleus from the carpogonium to the auxiliary cell, but the narrow downward growing septate filament which has not the appearance of containing a fertile nucleus, and the long distance between the supposed carpogonium and the bearing cell do not favour this interpretation. Moreover, I do not feel convinced that the carpogonium-like body is really a carpogonium; it might perhaps be some endophytic Rhodophycea.

IV. The Origin of the Nemathecia-producing Filaments.

It happens that procarps consist of more than four cells. As shown in fig. 8 *A*, carpogonial branches may bear a two-celled branch on their lower-most cell, and procarps without distinct carpogonium may sometimes consist of a greater number of irregularly arranged cells (fig. 10 *E*, *F*). I was for some time inclined to believe that such groups of cells might be able to give rise to the nemathecia-producing filaments; but I found no facts to support this supposition. After searching for a long time I finally succeeded in finding the origin of the filaments referred to by following the fate of the bearing cell that should normally become an auxiliary cell. This cell is originally uninucleate as shown in fig. 8 *B* to the left, but the nucleus is not visible in most of the figures, in some cases it is hidden by the granular matter (fig. 10 *B*). Later a greater number of small nuclei appear, much as in the analogous cell in *Phyll. membranifolia* (fig. 2). In the case pictured in fig. 10 *D* the auxiliary cell shows some 20 nuclei and these must all have arisen by division of the original single

nucleus, for a transfer of a fertile nucleus from the carpogonium cannot have taken place. The cell bore two carpogonial branches but neither of them had produced a normal carpogonium; the end-cells were filled with protoplasm in both branches, and one of them showed a distinct nucleus. A similar stage is shown in fig. 10 *C*, where the auxiliary cell also seems to contain several nuclei and no carpogonium is developed. In fig. 12 *D*, the bearing cell has taken an angular shape, but fig. 12 *E* shows more advanced stages; three bearing or auxiliary cells are here seen, one, very similar to that in fig. 10 *D*, having an irregular rectangular shape and bearing a two-celled carpogonial branch toward the lower surface of the leaflet, and two others, much larger, pushing out several long protuberances in all directions, partly penetrating between the surrounding cells of the foliole. The cell to the left contains several nuclei partly entering the protuberances. The carpogonial branches of these two procarps seem to be more or less degenerated. The next stage is represented in fig. 13 *B* where the auxiliary cell has become still more enlarged and the protuberances have produced, at their end, cells connected with the large cell by long threads of protoplasma. These cells form branched rows forcing their way between the surrounding cells of the gametophyte. A good deal of the parallel filaments above in the figure, forming a low excrescence on the mother organ probably derive from the auxiliary cell, but in the present case it was not possible to distinguish such cells from those of the gametophyte. The cells of the carpogonial branch could no longer be recognized. A similar or a slightly more advanced stage is shown in the Plate fig. I, where the large cell is seen near the centre of a young nemathecial wart.

This cell is shown more enlarged in figs. II and III, where the connection between the protuberances and the cells produced by them is very distinct. It seems that pit-connections may also be established between the large cell and cells of the gametophyte. As shown by DARBISHIRE, the nemathecia-producing filaments can be made more easily

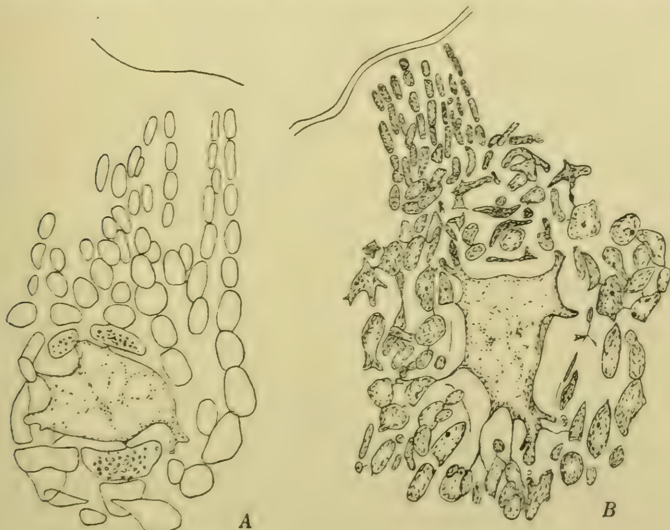


Fig. 13. *Phyllophora Brodiæi.* From Ellekilde Hage, Juel's solution. (Compare fig. 10). Auxiliary cells with protuberances. *A*. The protuberances penetrate between the surrounding cells. 625 : 1. *B*, more advanced stage. The protuberances have produced cells and cell-rows at their ends; some of these have begun to form a low tubercle, a young nemathecium. 390 : 1.

visible by the addition of iodine, when the latter will turn red-brown (not dark blue) owing to their contents of finely granulated floridean starch, while the cells of the mother plant remain unstained. In fig. V reproduced after such a preparation the nemathecia-producing filaments appear very distinctly owing to their dark contents. There seems in this case to be more than one fertile auxiliary

cell, or, as they may be named here, central cells, from which the starch-containing filaments radiate toward the periphery, having not yet pierced the cuticle. This has taken place in the case shown in fig. VII where a number of filaments issuing from a strongly developed intramatrical tissue are on the point of producing small cushions on the free surface of the frond. More advanced stages are shown in figs. IV, VI and VIII, where a large cell is seen at the centre of the nemathecial body. In most cases this cell has not longer a stellate shape but is roundish and surrounded by more or less densely jointed small round cells forming a medullary tissue while the outer part of the nemathecial body is built up by radiating filaments. The central cell in fig. VIII contains at least one small cell encompassed by the pseudopodes of the large cell which here and there form fusions.

The large cells just mentioned were observed by Schmitz (1893, p. 378) who, however, interpreted them as sterile cells of the host-plant attacked by fertile filaments, belonging, according to Schmitz, to the parasitic *Actinococcus subcutaneus,* which surround them and become connected with them by pits, where-upon the named cells increase to larger cells with abundant plasmatic contents, and he refers to fig. 2 on plate VII in his paper where a cell of stellate appearance is situated at the centre of the supposed parasitic cushion. A similar large stellate cell is figured by Schmitz under the young nemathecia of *Gymnogongrus Wulfeni,* they are interpreted by this author as a parasite named *Actinococcus aggregatus* (l. c. figs. 4—7). Here too we would remind the reader that Darbishire and Phillips observed in the neighbourhood of the nemathecia

(*Actinococcus*) what they supposed to be undeveloped procarps.

As shown by SCHMITZ and DARBISHIRE, the nemathecia-producing filaments force their way through the surface of the plant, in several places forming small cushions fusing together to one nemathecial body which at last becomes globular. In some cases one cushion only arises, on the upper face of the fertile frond, corresponding to the face where the procarp was situated; the intercellular filaments of the tetrasporophyte do not reach the opposite face of the frond (fig. IV). But usually a new cushion arises later, the filaments of the tetrasporophyte forcing their way to the opposite face of the frond where they pierce the surface at several points (fig. VII), forming a number of small cushions fusing into one. The lower cushion in fig. VIII has evidently originated from the same central cell as the upper one, but later than this, and its origin from a number of distinct points is still easily to be distinguished at the lower boundary of the cushion though the outline of the cushion does not show any traces of the early fusion. The original surface of the frond is very distinct as a dark line interrupted by bright spots where the filaments have pierced it. Two such opposite cushions may finally fuse into one globular nemathecium encompassing the foliole. In fig. VI is given a transverse section of a young globular nemathecium showing a large central cell in the middle and radiating filaments directed to all sides, but exhibiting nothing of the gametophyte except the central cell and some of the surrounding cells.

V. The Nemathecia.

As mentioned above, p. 13, the procarps arise either in particular small sexual leaflets springing from the upper border of the flat fronds or in the upper marginal zone of young flat fronds, and accordingly the nemathecia are either placed on the folioles (fig. 5) or are sessile in great number in the undulated upper margin of flat frond segments (fig. 6). In the first case they are either stipitate, the short stipe representing the lower, sterile portion of the leaflet, while the nemathecium occupies its upper end (fig. 5 *A* above, *B*), or the nemathecium is inserted at the base or at the margin of a leaf which was small at the moment when the procarps arose but which may sometimes attain a considerable size (fig. 5 *A*), in particular when the leaf is inserted at some distance under the upper margin (fig. 5, comp. Flora Danica tab. 1476, Kützing, Tab. phyc. XIX Taf. 74). Some of the nemathecia shown in fig. 5 *B* were probably inserted on the base of the leaves, issuing close to them.

The nemathecia arise, usually in the spring as it seems, and seem early to attain a considerable size. The maximal size is 2 to 3,5 mm. The full development is reached at the close of November when the sporangia begin to ripen, and ripe nemathecia were met with in December to February, but nemathecia with the maximal diameter are generally met with already in June and July, and in March to May they were found 1—1,5 mm. in diameter. As nemathecia of considerable size are to be found in early spring, and as the nemathecia occurring in winter are of different sizes it is probable that some nemathecia which are small in December may be kept without producing tetra-

sporangia and continue their life in the following season, whereas most nemathecia perish after the production of tetraspores.

When the nemathecial bodies have attained a certain degree of development they show a differentiation in an inner medullary tissue composed of roundish cells and an outer portion built up of radiating filaments consisting of

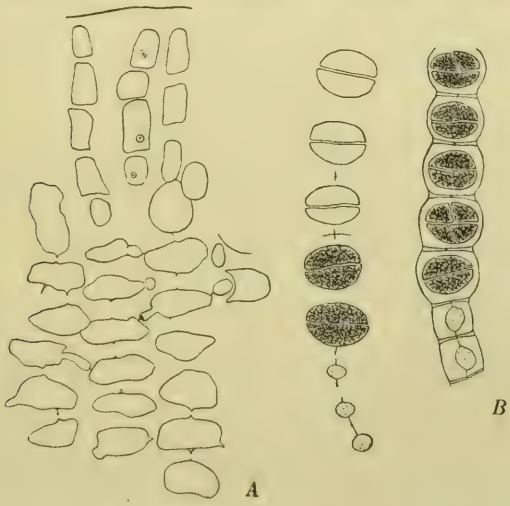


Fig. 14. *Phyllophora Brodiæi. A*, specimen from Middelfart, April; radial section of young nemathecium, showing the outer sterile cells and the fertile ones, the latter connected by primary pits and partly by secondary pits with cells of the contiguous filaments. *B*, fertile filaments from specimen gathered in Store Belt, November 24th, with sporangia in division. 625 : 1.

rather low cells connected by pits in the transversal walls (fig. 14). The 3 or 4 outermost cells in the cell-rows are longer and narrower and remain sterile, while the other cells develop into tetrasporangia (comp. Darbishire 1895, p. 24). As the sterile outermost cells are early differentiated and seem not to remain meristematic, and as the number of the fertile cells increases considerably during the development

of the nemathecium, an intercalary division of the inner cells seems to take place; but this question deserves further investigation. Moreover, it is remarkable that the fertile cells in the cell-rows are sometimes connected with cells in the contiguous cell-rows by secondary pits, formed in the usual way by the cutting off of a small cell by a longitudinal wall of one of the cells and fusing of it with a cell in the contiguous row (fig. 14 *A*). It should be of interest to study the fate of the migrating nuclei in this process.

The sporangia are first divided by a transverse wall and some time thereafter by two vertical or slightly inclined walls. They begin to ripen at the end of November, and nemathecia with ripe sporangia were met with in December to February.

VI. The Germination of the Tetraspores.

As mentioned above, Darbishire obtained germination of the tetraspores of *Ph. Brodiæi* and stated that they produce filaments and small more or less irregular cushions which he thought, in 1895, would develop to basal discs of *Phyllophora Brodiæi* under better conditions.

For studying the germination of the tetraspores fresh material was dredged in the Great Belt at the close of November 1925. The nemathecia-bearing plants were brought home to Copenhagen, cleaned and put in glass-vessels filled with filtered sea-water from the Great Belt, covered with glass-plates and placed in an unwarmed room facing north (Nov. 26th 1925). In some cases a little potassic nitrate was added to the water. The plants were placed so that the spores dropped on slides deposited on the bottom of the vessels, in some cases on shells of *Mytilus modiola.* After

one to two weeks numerous spores were set free, and the plants were then removed. The water in the vessels was now and then renewed and the slides cleaned with caution, diatoms, Cyanophyceæ and other Algæ being removed so far as possible.

The spores newly set free are globular naked cells (fig. 16 *A*) 7—9 μ in diameter, mostly 7—8 μ, containing a large

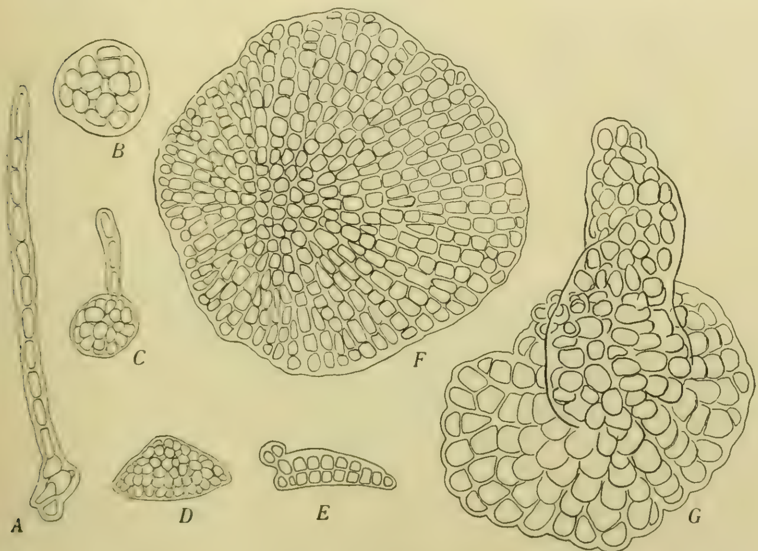


Fig. 15. Germlings from tetraspores of *Phyllophora Brodiæi* sown in the beginning of December 1925. *A—B*, 3½ months old, 22/3 1926. *C—F*, 6½ months old, 29/6 1926. *G*, 7 months old, 8/7 1926. *E*, optical vertical section. *A*, *C—F*, 350 : 1. *B*, 410 : 1. *G*, 560 : 1.

chromatophore, a hyaline, feebly refractive body, probably the nucleus, and a great number of small refractive grains. A month later (January 11th) numerous spores had surrounded themselves with a membrane and were divided by a vertical wall into two cells, more rarely into three. In most cases the bodies had not changed shape but were a little enlarged in circumference; only a few of them were

about to produce a thinner prolongation before or after the formation of a new partition wall. In March the plants had developed into small multicellular, often irregular cushions, partly with long filamentous outgrowths (fig. 15 *A*, *C*); sometimes the filamentous portion was most developed (fig. 15 *A*). At the close of June the best developed germ-

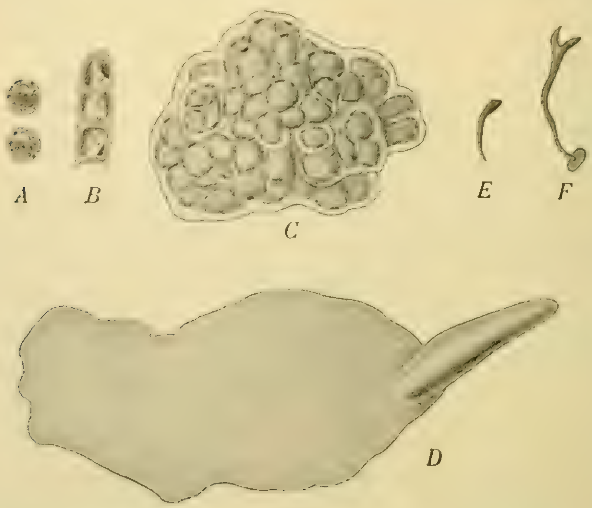


Fig. 16. *Phyllophora Brodiæi.* Germlings from tetraspores sown in the beginning of December 1925. *A*, spores newly liberated. *B*, portion of filament from germling. *C*, eight months old germling, $^{14}/_{8}$ 1926. *D*, 14 months old germling with upright shoot springing near the border $^{10}/_{2}$ 1927. *E* and *F*, 20 months old germlings, $^{18}/_{8}$ 1927. *A—C*, 625 : 1. *D*, 70 : 1. *E—F*, 6 : 1.

lings were regular orbicular discs without filamentous outgrowths, built up of regularly radiating, closely united filaments, but polystromatic and thicker in the middlemost part (fig. 15 *F*). The discs were rich in starch. In other cases they were smaller and thicker, often conical (fig. 15 *D*). At that time some of the cushions produced an upright shoot from the upper face, usually from the centre

(fig. 15 *G*). The cultures were kept going during the following year, but owing to the bad conditions in the old cultures the germlings now grew very slowly if at all. The best developed germlings were obtained from the bottom and the side walls of a glass-vessel in which a nemathecia-bearing plant had been laid down. Fig. 16 *D* shows a well developed, about 14 months old, oblong basal disc much resembling that found in the Baltic Sea by DARBISHIRE and figured by him in 1895 fig. 24. It bears a young terete upright shoot near the margin. The germlings drawn in fig. 17 are about 18 months old; they have a large roundish basal disc and a simple, terete or somewhat complanated upright shoot springing from the centre. Those pictured in fig. 18 are about 14 months older; they have a flat upright frond terete at the base, flattened and branched upwards, on the sides or at the top, in fig. 18 *B* by dichotomy. The disc shown in fig. 18 *D* bears two erect shoots near the border. A better developed 3 mm. high, dichotomously branched 20 months old frond is shown in fig. 16 *F*. The two and a half year old plants shown in fig. 18 were up to 2 mm. high.

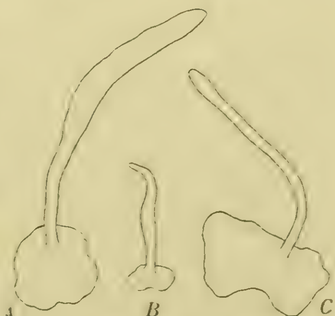


Fig. 17. *Phyllophora Brodiæi.* Germlings from the bottom of a glass vessel in which a fructiferous plant was deposited at the close of November 1925, picked up 18/6 1927 (18 months old). 33 : 1.

The dimensions of the last-named fronds are evidently very small for plants of that age, but that is certainly only due to the bad conditions, in particular in the old cultures which were not sufficiently taken care of. At any rate, they agreed as well with young fronds of *Phyllophora*

Brodiæi found in nature as could be expected under these conditions, and there can be no doubt of their identity. The germination of the spores of the nemathecia then shows conclusively that the latter do not belong to a parasite but that they represent a link in the development of *Phyllophora Brodiæi.*

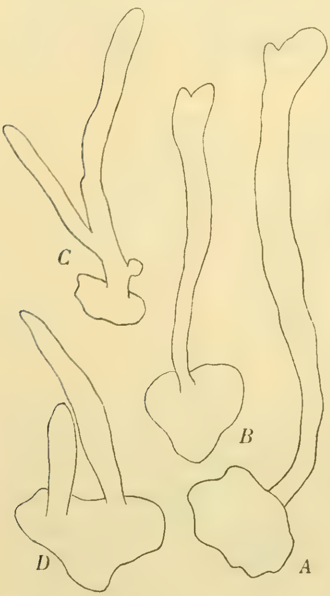


Fig. 18. *Phyllophora Brodiæi.* 32 months old germlings from the walls and the bottom of the vessel mentioned in fig. 17. 33 : 1.

Chemin has recently (1927) observed the germination of the tetraspores of another nemathecium interpreted as a parasite, namely that of *Gymnogongrus norvegicus* described by Schmitz as *Actinococcus peltæformis* (Schmitz 1893, p. 387). The spores sowed in glass-vessels developed basal discs which after two to three months produced upright shoots of the same structure as in *G. norvegicus.* As ascertained by Chemin, this species has distinct sexual and asexual individuals; the author has found no facts supporting the hypothesis of the parasitical nature of the nemathecia, and he therefore considers *Gymn. norvegicus* as a normal diplobiontic Floridea.

Conclusions.

From what has been shown above it must be concluded that all individuals of *Phyllophora Brodiæi* are (actually or virtually) sexual plants and that free-living tetraspore-bearing

plants do not exist. The antheridia and the procarps usually occur on the same individual; they arise either in particular sexual folioles or in the upper margin of the flat fronds. The antheridia quite agree with those in *Phyll. membranifolia*. As in this species the procarps consist of a three-celled carpogonial branch and a bearing cell or auxiliary cell, but the carpogonial branch is rather variable, perhaps a consequence of degeneration, and it is probable that fertilization does not take place; at all events it has not been ascertained. The auxiliary cell much resembles that in *Ph. membranifolia*; in both species it has first one nucleus but later becomes plurinuclear. But while the latter is a typical diplobiontic species in which the auxiliary cell pushes out a number of outgrowths developing into the gonimoblast filaments, the auxiliary cell in *Ph. Brodiæi* likewise pushes out a number of protuberances, but these give rise to cell-filaments forcing their way between the cells of the gametophyte in various directions but at first especially outwards where they give rise to a wartlike excrescence which develops into a nemathecium in the inner part of which the enlarged auxiliary cell or central cell is to be seen. The radiating filaments of the nemathecium give rise to seriate tetrasporangia, which ripen in winter. The system of cell-filaments issuing from the auxiliary cell in *Ph. Brodiæi* and their products thus represent the tetrasporophyte which is not here as in other Florideæ an independent free-living organism, but grows out in continuity with and "parasitically" upon the gametophyte generation. Cystocarps are never produced, the carposporophytic phase has been abandoned, and in its place a tetrasporophyte is developed. The vegetative part of the latter is only represented by the intramatrical cell-filaments.

The above mentioned suggestion of Reinke that *Actinococcus subcutaneus* might possibly be an asexual generation of *Phyll. Brodiæi* growing parasitically on the sexual generation is thus fully confirmed.

The reproduction of *Phyllophora Brodiæi* now elucidated is very peculiar; no other instance agreeing with it has hitherto been described. Only the remarkable reproduction in *Liagora tetrasporifera* Børgs. discovered by Dr. F. Børgesen (1927, p. 39) can be compared with it. Most of the species of this genus, belonging to the *Helminthocladiaceæ*, have normal cystocarps, arising probably after a fertilization directly from the carpogonium, and the end-cells of which give rise to a carpospore, while tetrasporangia are not known with certainty. The species referred to has apparent cystocarps arising in the same way as those of the other species, but the end-cells of the cystocarpial filaments undergo a quadripartition and yield each a cruciately divided tetrasporangium. Thus the "cystocarp" does not, properly speaking, deserve this designation; it is not a carposporophyte but a tetrasporophyte and can be compared with the tetrasporophyte generation of *Phyllophora Brodiæi*. There is, however, a significant difference in that the tetrasporophyte of *Liagora tetrasporifera* has the appearance and the structure of a cystocarp with the only difference that the carpospores are replaced by tetrasporangia, while the tetrasporophyte in *Ph. Brodiæi* is differentiated in an intramatrical, vegetative part and a number of extramatrical cushions fusing together into a large globular nemathecium showing no resemblance to a cystocarp but having a structure similar to that of the nemathecia in the diplobiontic species of the same genus.

The tetrasporangia appear in *Liagora tetrasporifera* within

a systematic group which is typically haplobiontic, where these organs as a rule do not take part in the normal life-cycle. The extraordinary appearance in question within a genus which has otherwise normal cystocarps suggests that it is due to a mutation, tetrasporangia having appeared here instead of carpospores. In the case of *Phyllophora Brodiæi* it seems more probable that the origin of the parasitic tetrasporophyte has been occasioned by the degeneration of the procarps and the consequent absence of fertilization and of carpospores. The tetrasporophytes — like the gonimoblasts in *Ph. membranifolia* — arise as outgrowths from the bearing or auxiliary cell, but these outgrowths have not the character of gonimoblast filaments; they appear first as vegetative intramatrical filaments, and only later do the nemathecia arise. The whole tetrasporophyte has the character of a much reduced form of the normal tetrasporophyte as it is known in *Ph. membranifolia*; the reduction of the vegetative body is due to the parasitical life, and the globular form of the nemathecium is due to the small size of the latter.

For a full elucidation of the question here treated of, a closer cytological research has yet to be made. It ought in particular to be ascertained whether or not a fertilization takes place, and whether the formation of the tetraspores is initiated by a reduction division.

The other nemathecia occurring within the *Gigartinaceæ* and regarded by Schmitz as belonging to parasites analogous to *Actinococcus* and referred to the genera *Colacolepis* and *Sterrocolax*, will not be treated here. As mentioned above, Chemin has examined the nemathecia occurring

on *Gymnogongrus norvegicus,* named by Schmitz *Actinococcus peltæformis*[1], and observed the germination of the tetraspores produced by them, and he found that these nemathecia are the true organs of the *Gymnogongrus,* occurring only on the asexual plants. I have found the same for the nemathecia of *Phyllophora epiphylla (Ph. rubens),* according to Schmitz belonging to a parasite *Colacolepis incrustans.* This will be mentioned in another paper where also the nemathecium of *Ahnfeltia plicata,* considered by Schmitz as a parasite, *Sterrocolax decipiens,* will be treated of.

I am much indebted to Dr. Henning Petersen for kindly giving me fixed material of *Phyllophora Brodiæi,* to the same and to Mr. Erik J. Petersen m. sc. and Mr. G. Nygaard m. sc. for their valuable aid in executing the photographs reproduced on the plate.

[1] Phillips erroneously names it *Colacolepis peltaeformis* (l. c. p. 251).

Bibliography.

J. G. Agardh (1851), Species genera et ordines Algarum. Vol. II, p. I. Lund.

F. Børgesen (1927), Marine Algæ from the Canary Islands. III. Rhodophyceæ, Part I. K. D. Vidensk. Selsk. Biolog. Meddelelser, VI, 6. København.

E. Chemin (1927), Sur le développement des spores d'Actinococcus peltæformis Schm. et la signification biologique de cette Algue. Bulletin de la soc. bot. de France 1927, p. 912.

O. V. Darbishire (1894), Beitrag zur Anatomie und Entwicklungsgeschichte von Phyllophora. Botan. Centralblatt. Bd. 57, p. 361.

— (1895), Die Phyllophora-Arten der Westlichen Ostsee Deutschen Antheils. Wissenschaftl. Meeresuntersuchungen herausg. v. d. Kommission z. Unters. d. deut. Meere. Neue Folge. I. Band. Heft 2. Kiel 1895.

— (1899), On Actinococcus and Phyllophora. Annals of Botany. Vol. XIII, p. 253; pl. 15.

M. Gomont (1894), Note sur un mémoire de M. Fr. Schmitz intitulé Die Gattung Actinococcus Kützing. Journal de Botanique 1er avril 1894. Paris.

Greville (1830), Algæ Britanicæ. Edinburgh.

L. Kolderup Rosenvinge (1893), Grønlands Havalger. Meddelelser om Grønland III. Kjøbenhavn. (Les Algues marines du Groenland. Ann. d. sc. nat. 7e série XIX 1894).

— (1898), Deuxième Mémoire sur les Algues marines du Groenland. Meddelelser om Grønland 20.

F. T. Kützing (1843), Phycologia generalis. Leipzig.

H. C. Lyngbye (1819), Tentamen hydrophytologiae danicae. Hafniae.

R. W. Phillips (1925), On the genera Phyllophora, Gymnogongrus and Ahnfeldtia and their parasites. The New Phytologist, Vol. 24, No. 4.

Henrik Printz (1926), Die Algenvegetation des Trondhjemfjordes. Skrifter utgitt av d. Norske Videnskaps-Akademi i Oslo. Math. naturv. Kl. 1926. No. 5. Oslo.

Fr. Schmitz (1893), Die Gattung Actinococcus Kütz. Flora 1893.

D. Turner (1809), Fuci, Vol. II. London.

Explanation of Plate.

Microphotographs of nemathecia of *Phyllophora Brodiæi.* Figs. I—III, VI, VII from a specimen from Ellekilde Hage, Juni 30th 1910, Henn. Petersen. Figs. IV, V, VIII from a specimen from Øresund east of Taarbæk Flak, October 7th, Søren Lund.

Fig. I. Section of young nemathecial body. 110 : 1.

Figs. II and III. The central cell of the former. 375 : 1.

Fig. IV. Vertical section of nemathecium only developed on one side of the frond. 57 : 1.

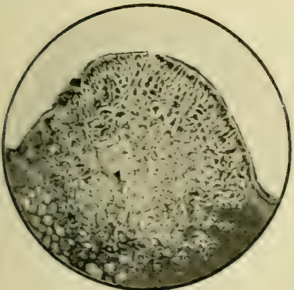
Fig. V. Section of frond with nemathecia-producing filaments, stained with iodine, radiating toward the periphery. 88 : 1.

Fig. VI. Transverse section of nemathecium. 77 : 1.

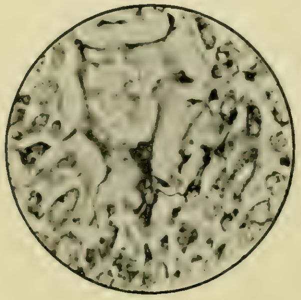
Fig. VII. Nemathecia-producing filaments forcing their way through the cortex. The medullary tissue, interwoven with numerous nemathecia-producing filaments is indistinct owing to the fact that this tissue was situated at a higher level. 96 : 1.

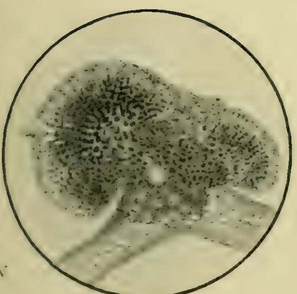
Fig. VIII. Vertical section of nemathecium showing the central cell and a smaller nemathecium on the under face of the frond, evidently arisen by fusion of several small cushions. 64 : 1.

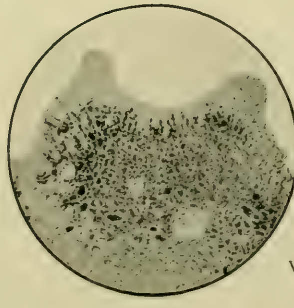
Forelagt paa Mødet den 19. April 1929.
Færdig fra Trykkeriet den 24. August 1929.

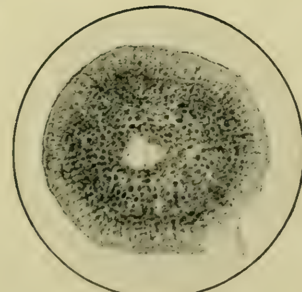

I

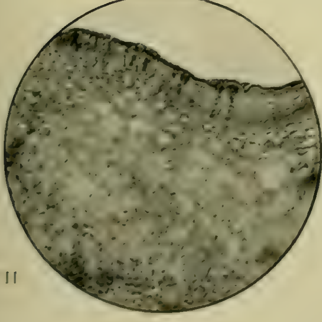

II

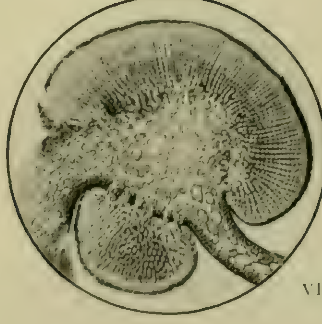

III


IV


V


VI


VII


VIII

H. MØLHOLM HANSEN

STUDIES ON THE VEGETATION OF ICELAND

1930

ARBEJDER FRA DEN BOTANISKE HAVE I KØBENHAVN. Nr. 116

ARBEJDER FRA DEN BOTANISKE HAVE I KØBENHAVN. Nr. 116
REPRINTED FROM THE BOTANY OF ICELAND VOL. III PART I

10.

STUDIES ON THE VEGETATION OF ICELAND

BY

H. MØLHOLM HANSEN

WITH 12 PLATES

1930

CONTENTS.

PREFACE.

Among the results achieved by Danish botanical research, two especially aroused my liveliest interest, viz. W. Johannsen's demonstration of the fixity of the genotype ("the genotype of homozygotic organisms is normally just as "fixed in type" as e. g. chemical composition" (Arvelighed 1918, p. 102)), and C. Raunkiær's demonstration of the distribution of the life-forms within the various climatic zones ("even the most widely separated regions with entirely different floras in a floristic respect but with essentially the same climatic conditions for plant life show in the main the same biological spectrum" (Livsformernes Statistik som Grundlag for biologisk Plantegeografi. 1908, pp. 68—69).

From these two facts I, as an impartial observer, drew the conclusion that in Nature the development of forms as sketched in "Livsform og Alder" (Bot. Tidsskr. **40**: 193—203, 1928) must in the last instance be regarded as a physico-chemical process, the simplest manifestation of which is to be found in the transformation of a chemical combination, such as e. g. that of H_2O from vapour through water to ice (the gaseous, liquid, and solid phases respectively) during progressively decreasing temperature. In this way the species should be chemical combinations whose phases are their life forms.

This, however, is merely a theory, the correctness of which is primarily determined by its fruitfulness as a scientific working hypothesis. Hence it was expedient to collect further material to illustrate the relation between form and environment. As assistant to Professor Raunkiær in his investigation of the preserved heath at Nørholm (in the summers of 1921—1924) I was fortunate enough to become acquainted with the zone formation around collections of water, to which the attention of botanists had already been drawn in "Vesterhavets Øst- og Sydkysts Vegetation" (Raunkiær 1889). At Nørholm Heath I was able to collect material to elucidate the amount of individual species and life-forms in the various zones of moisture, and thanks to financial

aid from the "Japetus Steenstrup Legat" I could continue and verify my observations from Nørholm Heath in the summer of 1924 by a journey through the dune region along the west coast of Jutland.

When I had taken my Master's degree in the autumn of 1924, thanks to testimonials from my teachers Professors C. Raunkiær, L. Kolderup Rosenvinge and C. H. Ostenfeld, I obtained financial aid from the Carlsberg Foundation and from Dansk-Islandsk Forbundsfond for phytogeographical researches in Iceland.

In this work, too, luck befriended me. While making my preparations for the journey to Iceland, I was able to attend a course of lectures on the vegetation of Greenland given at the University in the spring term of 1925 by Professor Ostenfeld. These lectures have been of the greatest importance to me, partly during my work in Iceland, and partly during the subsequent more thorough treatment of the material. Thus it is to them I owe the impulse to include in my investigations the vegetation under the various depths of snow-covering, my original intention being only to investigate the vegetation in the various zones of moisture. Also the division of the Icelandic flora into species-groups according to the geographical distribution of the species, the setting up of species group spectra on a parallel with the biological spectra, and the application of the species group spectra for a more thorough characterisation of the environment, are fruits of these lectures. By these investigations the conception of the species as chemical combinations has been further confirmed.

I have regarded the financial aid which rendered possible the researches described in this treatise as a great mark of confidence and, to the best of my ability, I have endeavoured not to disappoint the trust placed in me. Through this work I beg the Trustees of the Carlsberg Foundation and the Trustees of the Dansk-Islandsk Forbundsfond to accept my respectful thanks. Finally I owe thanks to Miss Annie I. Fausböll, M. A., who has undertaken the difficult task of the English translation.

Copenhagen, June 1928.

I. THE ICELANDIC CLIMATE.

The climate of Iceland is, according to Thoroddsen 1914 p. 265 f., determined not only by the geographical situation of the island and the prevalent winds of the North Atlantic, but also to a great extent dependent on the current-conditions of the surrounding seas.

The south and west coasts of Iceland are washed by the warm Gulf Stream, while on the north and east coasts we have the cold polar current. The waters of the two currents meet in the sea outside south-east of Iceland itself, on a line running from Vatnajökull to the Færoes and to the north-west off Cape Horn. It is as well to note at once that in the highland tracts of Iceland between these two points, we find a series of jökulls in decreasing volume from Vatnajökull to the jökulls of Vestfirðir.

The current conditions may be more precisely described as follows: The Gulf Stream washes the shores of Iceland all along the south and south-west coasts of the island, gradually gathering to a stream which follows the coast towards the west and further towards the north. Off Cape Horn, this branch of the Gulf Stream, known as the Irminger Current, encounters the Polar Current coming from the Polar Sea. A branch of the Irminger Current again is forced outward from the coast by this Polar Current, and another branch, rounding Cape Horn, follows the northern coasts of the island to the eastward, cooling as it goes, and finally disappearing under the water masses of the Polar Current itself. At Grímsey, it is still of great importance, but farther east, it vanishes altogether, and the shores of East Iceland are thus washed solely by the polar water. The situation, then, is as follows: the south and west coasts, i. e. the coast south of the "jökullsline" is washed exclusively by water from the Gulf Stream. The north and east coasts are washed by polar water; the eastern by this alone, the northern by this and Gulf Stream water as well.

According to Thoroddsen (1914) these features are of great importance in their bearing on life in the sea, both as regards its flora and fauna. We find, in fact, on the north and east coast, a flora and fauna of arctic character, whereas those of the south and west coasts are of temperate character. Up to the present, this has been confirmed by investigations on the flora of marine algæ, plankton, and the fish fauna, as well as deep sea and bottom fauna. The same conditions seem to be of no slight importance as regards life on land, as the present research inter alia will show.

The temperature along the coast shows, according to Thoroddsen, the following values: On the south and west, the mean surface temperature is 5—7° C., while to the north and east it is somewhat lower, 3—4° C.

At the Vestmannaeyjar (South Iceland) the surface water during the coldest months (Decbr.—Febr.) shows a monthly average of abt. 4° C., and in the hottest months (July—Aug.) abt. 11° C., the annual mean temperature being abt. 7° C.

Stykkishólmur (W. Icel.) has for Febr.—March temperatures of 0.3°—0.4° C. and July—Aug. 10.4°—10.6° C., with an annual mean temperature of 4.9° C. Grímsey (N. Icel.) a March temperature of 0.7° C., August 7.4° C., with an annual mean of 3.8° C., and Papey (E. Icel.) has a Febr.—March temperature of 0.4°—0.5° C., Aug.—Sept. 6.6°—6.2° C. with a mean temperature for the year of 3.2° C.

It will be seen from this that the temperature of the surface water decreases parallel with the volume of Gulf Stream water. From South Iceland west and northward round to East Iceland we have the following values for mean annual temperature: 6.9°—4.9°—3.8—3.2° C. East Iceland has the lowest mean temperature and the greatest volume of the Polar water; South Iceland the greatest volume of Gulf Stream water and the highest mean annual temperature.

The temperature of the air is closely correlated to this (see Table 1), being, however, nearly always lower than the surface temperature of the sea water, the difference amounting on the average to a couple of degrees. We find, for instance for the temperature of the air, the following mean values: 5.1°—3.0°—1.5°—2.4° C. that is, following the coastline round from S-W-N-E.

The greatest difference is apparent during the coldest months of the year, October to March, less in summer from April—Sep-

tember, and we find also, that only on the south and west coasts is the temperature of the air, on the average, always lower than that of the sea water, whereas on both north and east the temperature of the air may remain for months higher than that of the sea water, this being especially the case on the east coast.

The Polar Current carries with it great masses of ice. This current of ice can either strike Langanes or the east coast of Vestfirðir, south of Cape Horn. If it strikes Vestfirðir, then it is borne by the eastward going current along the north coast, rounding Langanes and drifting on along the east, sometimes even also along the south coast, until all the ice has melted or disappeared out into the Atlantic. When the current of ice strikes Langanes or Melrakkasljetta, it is carried out into the Atlantic by the same current. The quantity of drift ice varies to an extraordinary degree; in some years there may be none at all, while in others, "ice years", it may lie about until far on in summer. The result is seen in great climatic fluctuations.

The winds in Iceland are determined by two centres of low barometric pressure, one lying south-west of Iceland, and another, minor one, situated towards the north-east. The former constitutes the principal factor in determining the state of the wind, and in consequence, easterly winds are most prevalent, especially on the west. In East Iceland, the eastern minimum is of no slight importance, westerly winds being here of more frequent occurrence than in other parts of the country.

The highest frequency percentage for calm occurs in summer, and this applies to all parts of the country; the highest percentage is recorded from the Vestmannaeyjar, with an average value of 22, a percentage of calm in winter of 10—20 and in summer of 25—30. At Grimsey the percentage of calm is lowest, on an average about 10, 4—6 in winter, 16—19 in summer. East and West Iceland show somewhat similar conditions, though in winter the percentage is higher, about 10.

The number of stormy days is closely correlated to this (see table 1). It applies to all parts of the country that the number is highest in winter, lowest in summer. It is, however, very variable. It storms most frequently in the south-west and south. Thus Stykkishólmur has, on an average, 50 stormy days per annum, the Vestmannaeyjar 25. The number is considerably less for the north and east. Grímsey has 11, Berufjörður only 8 stormy days annually.

These facts, however, seem merely to apply to conditions either at the level of the sea, or perhaps only by the coast. If we take a station like Möðrudalur, situated approximately on a line connecting Grímsey with Berufjörður, but at an altitude of 480 m above sea level, this station shows an average of 39 stormy days annually, though distributed in such a way that the winter has the highest, the summer the lowest number of stormy days.

Temperature conditions. Above we saw that the temperature of the air near the sea was very closely correlated to the surface temperature of the sea water, but with the addition that the temperature of the sea water was always higher, 1—2° C., than that of the air. In table 1 are shown the average annual and monthly mean temperatures for South Iceland, West Iceland, East Iceland, and the highland Möðrudalur. There is a considerable difference between the coastal stations on the one hand and the highland on the other hand, a difference which may also be shown to exist between the coastal stations mutually.

The mean temperature is highest in South Iceland, being 5.1° C. at the Vestmannaeyjar. The coldest month here is December with a mean temperature of 1.2°, the warmest month is July with 10.6°. The difference between the coldest and warmest months is 9.4°. West Iceland, Stykkishólmur, has a mean annual temperature of 2.8°, the coldest month, February, registering a mean temperature of 2.7° below zero, the warmest month (July) 9.7°, with a difference of 12.4°.

Berufjörður in the east country has the same mean annual temperature, 2.3°; here March is the coldest month, 1.7° below zero, July the warmest, 8.5°, and the difference between the coldest and warmest months is somewhat less, 10.2°.

Grímsey, in the north country, has a mean annual temperature of 1.5°, a mean temperature for March of 3.6° below zero, for July of 7.0°, difference 10.6°.

The highland is considerably colder. The mean annual temperature for Möðrudalur is 0.2° below zero, the January temperature, 7.2° below zero, the July temperature 10.0°. The difference, 17.2°, is thus considerably greater than that of the coastal stations.

The number of frosty days is closely correlated to the temperature conditions. The smallest number is recorded from South Iceland which shows an average of 109 per annum. Grímsey has the greatest number, 192. Berufjörður lies between these two extremes with 158 frosty days and Stykkishólmur with 166 frosty days. Un-

fortunately there are no records from the highlands. The number is probably considerably higher here.

Precipitation. The precipitation in summer is principally rain, in winter principally snow. The annual precipitation is greatest to the south and east, decreasing towards the west and being comparatively small in the north.

In the Vestmannaeyjar the annual precipitation is 1319 mm. (see table 1), distributed over 207 days, in East Iceland it is 1117 mm., distributed over 146 days, in West Iceland, Stykkishólmur, the amount of precipitation is already considerably lower, 662 mm. distributed over 117 days. From the highland tracts we have unfortunately no investigations on the amount of precipitation for the whole year, so it is impossible to draw any comparison with the coastal stations. The number of days with precipitation for Möðrudalur is 153, thus somewhat higher than for Grímsey, corresponding fairly well with East Iceland. It may, however, be taken for granted that the amount of precipitation is not nearly as great in the highland tracts as at the coast. Observations from some of the summer months at a highland station, Grímsstaðir, about 385 m above the sea, in the vicinity of Möðrudalur, show an average monthly value for the five months May—September of 26.8 mm, while the average monthly amount of precipitation for Grímsey for the five months is 31.4 mm.

The amount of precipitation and the number of days with precipitation are highest in the autumn and winter months, lowest in spring and summer. This applies especially to the regions to the south of glaciers.

In winter the precipitation occurs principally in the form of snow, though with a difference in the different parts of the country. Table 1 shows the number of days with snow for the different stations where this has been investigated. In the highland tracts and the north country snow predominates, in the south there are comparatively few days with snow; while snow is rare here in the summer, it is more frequent in the north. In the highland tracts snow in summer is even the rule. At Möðrudalur the average monthly number of days with snow in summer is 2—4.

Unfortunately there are no observations on the depth and duration of the snow-covering in the various regions of Iceland. As to the depth of the snow-covering Thoroddsen states that it varies much with the situation and the altitude above the sea, and from one year to another. As to its duration he states that the snow

TABLE 1. **Climatic Conditions in Iceland.**

I. Berufjörður, East Iceland (64° 40′ N., 14° 15′ W., 18 m above sea level).
II. The Vestmannaeyjar, South Iceland (63° 26′ N., 20° 18′ W., 8 m above sea level).
III. Stykkishólmur, West Iceland (65° 5′ N., 22° 46′ W., 11 m above sea level).
IV. Grímsey, North Iceland (66° 34′ N., 18° 3′ W., 2.5 m about sea level).
V. Möðrudalur, Highland Tracts (65° 19′ N., 15° 15′ W., about 480 m above sea level).

The table has been compiled after Thoroddsen (the lowland stations), Thorkelsson (the precipitation values for all stations), and Meteorologisk Aarbog Part II, 1886—1916 (the highland station). The lowland stations comprise the years 1872—1906, the precipitation values cover an additional number of years.

	Year	January	February	March	April	May	June	July	August	September	October	November	December
I. Mean temperature of surface water in degrees C°	3.2	0.7	0.4	0.5	1.5	3.1	4.8	6.0	6.6	6.2	4.3	2.6	1.3
Mean temperature of air	2.8	÷1.2	÷1.5	÷1.7	1.0	3.7	6.8	**8.5**	8.3	6.6	3.3	1.1	÷1.0
Mean precipitation in mm	1174	128	99	77	83	73	67	64	82	126	124	113	139
Number of days with precipitation	146	15	14	12	11	10	9	10	10	13	13	14	15
Number of days with snow	50	8	8	9	5	3	0.4	»	0.1	0.5	3	6	7
Number of days with fog	171	11	11	11	14	17	19	21	18	16	12	11	10
Number of days with frost	158	24	22	25	18	10	2	»	0.3	2	13	18	24
Number of days with gales	8	1	1	1	1	0.4	0.1	0.2	0.2	0.4	1	1	1
II. Mean temperature of surface water in degrees C°	6.9	4.1	4.1	4.5	6.1	7.7	9.5	10.9	10.8	9.1	6.8	5.1	4.1
Mean temperature of air	5.1	1.3	1.3	1.4	4.0	6.3	9.0	**10.6**	10.2	8.2	5.1	3.0	1.2
Mean precipitation in mm	1354	150	123	118	94	80	80	77	76	139	144	135	138
Number of days with precipitation	207	21	18	17	17	15	15	15	14	18	19	19	19
Number of days with snow	44	9	8	8	4	1	0.2	»	»	0.3	2	4	8
Number of days with fog	49	2	2	2	3	5	8	8	6	5	4	2	2
Number of days with frost	109	20	18	17	10	3	0.1	»	0.4	1	8	13	19
Number of days with gales	25	4	3	3	2	1	0.5	0.3	0.3	2	2	3	4

TABLE 1 CONTINUED.

	Year	January	February	March	April	May	June	July	August	September	October	November	December
III. Mean temperature of surface water in degrees C°	4.9	0.9	0.3	0.4	1.7	4.7	8.2	10.4	10.6	9.1	6.3	3.7	1.8
Mean temperature of air	2.8	÷2.2	÷2.7	÷2.3	0.8	4.3	7.8	**9.7**	9.2	6.8	3.2	0.5	÷1.3
Mean precipitation in mm	654	74	69	50	37	37	37	34	41	70	77	69	62
Number of days with precipitation	207	21	19	18	16	15	15	14	14	18	18	19	20
Number of days with snow	84	16	14	13	8	3	0.4	0.1	»	1	4	10	14
Number of days with fog	9	0.3	0.5	0.4	0.7	2.0	1.3	1.6	1.3	0.7	0.3	0.4	0.3
Number of days with frost	166	26	25	26	19	9	1	»	0.1	1	13	20	26
Number of days with gales	50	6	6	6	4	4	2	1	2	4	5	5	5
IV. Mean temperature of surface water in degrees C°	3.8	1.8	1.4	0.7	1.3	2.6	4.2	6.6	7.4	6.9	5.3	4.1	2.9
Mean temperature of air	1.5	÷2.0	÷3.0	÷3.6	÷1.2	1.7	5.5	**7.0**	6.8	5.7	2.5	0.0	÷1.3
Mean precipitation in mm	274	16	17	17	13	15	18	28	34	34	35	29	20
Number of days with precipitation	117	10	10	10	9	8	6	8	10	11	12	12	11
Number of days with snow	64	7	8	8	7	5	2	0.5	0.4	2	6	9	9
Number of days with fog	46	1	1	2	4	6	7	10	8	4	2	0.5	0.3
Number of days with frost	192	25	24	27	24	17	5	2	2	4	17	21	24
Number of days with gales	11	2	1	1	0.3	0.2	0.4	0.2	0.2	1	1	2	2
V. Mean temperature of air	÷0.2	÷7.2	÷6.7	÷6.4	÷2.1	3.2	8.5	**10.0**	7.4	4.0	÷1.0	÷4.7	÷6.8
Mean precipitation in mm (Grimstaðir)	»	»	»	»	»	19	27	29	34	26	»	»	»
Number of days with precipitation	153	13	13	14	13	12	8	12	15	12	13	13	15
Number of days with snow	109	12	12	13	12	8	3	2	4	7	10	12	14
Number of days with fog	11	1	1	1	1	1	0.3	1	1	1	1	1	1
Number of days with gales	39	6	4	4	2	2	3	1	1	4	3	4	5

often remains on the ground for a long time in the north country, while this is more rarely the case in the south-west. In the south country it may often happen that the lowland tracts are destitute of snow for months on end. Here the precipitation is in the form of rain, whereas, in the adjacent highland tracts it falls as snow.

Fog. In the calm and rainy regions to the east and south, fogs often occur, whereas the more storm-blown west coast is rarely visited by fog. Thus Berufjörður has no less than 171 annual days of fog, while Stykkishólmur has only 9 days of fog. Fog occurs most frequently in summer, still even the winter months show a number of foggy days on the east coast, about 10.

If on the basis of the above statements, we attempt to make a comprehensive survey of the climate of the separate parts, we must distinguish between a lowland climate and a highland climate.

The lowland climate is of a pronounced oceanic character with but slight difference between the summer and winter temperatures. The climate of the east country is cold, foggy, and rainy, with slight circulation of the air. That of the south country is warmer, especially in winter. In the west country, again, the temperature falls somewhat, and the precipitation is considerably less. Fog is rare, but on the other hand, the weather grows very stormy. The north country is the coldest, but on the other hand the driest. Fog and storm are not very common (the station here is Grímsey, which does not, probably, give a perfectly valid picture of the climatic conditions of the north country).

The main difference between the north and south countries is that the north country is more continental in character than the south country. The summer temperature is very much the same for both parts, the average for all stations being about 9—10° C., but the winter is considerably colder in the north than in the south, 4° C. below zero in the north, 1° C. below zero in the south. The difference between the warmest and the coldest month is 13.2° in the north, but only 11° in the south.

The highland climate. The climate of the highland tracts is considerably more continental than that of the lowlands. The summer temperature is very much the same in both places, but the winter temperature is considerably lower in the highland tracts and

the difference between the coldest and the warmest months is thus great, 17.2° C. The precipitation is slight and storms are frequent. To this must further be added a probably very thick and at any rate constant covering of snow in winter.

Of interest in connection with plant geography is further the situation of the jökulls and the snow-line. We have previously seen that most of the jökulls gather along a line connecting the two places where the waters of the Gulf Stream and the polar water meet, respectively to the south-east and the north-west of Iceland. The line begins with the large Vatnajökull on the south-east and extends north-westwards over Tungnafellsjökull, Hofsjökull, Langjökull, and Eiríksjökull until it terminates in Gláma and Drangajökull in Vestfirðir. To the north of the range of jökulls there are only a few small jökulls on the peninsula between the Eyja- and Skagafjörður while to the south we have the large Mýrdalsjökull and some smaller ones, more especially Snæfellsjökull.

The area of the jökulls is largest towards the cold, humid, and foggy eastern regions and decreases strongly towards the north-west. The area of Vatnajökull is about 8000 km²; of Hofsjökull about 1350 km², of Langjökull 1300 km², of Gláma about 60 km², and of Drangajökull 350 km². Vatnajökull's greatest altitude above sea level is 2119 m., that of Hofsjökull 1700 m., of Langjökull 1400 m., of Gláma and Drangajökull about 900 m.

The snow-line lies at very different altitudes, coming down lowest on the south side, while on the north side it lies somewhat higher, the east and west sides occupying an intermediate position. On Vatnajökull the snow-line on the north side lies at a height of 1300 m., on the north side of Hofsjökull at 1200 m., and on the north side of Langjökull at a height of 1100 m. On the south side the snow-line lies at a level of 900 m. In Vestfirðir the height of the snow-line above the sea is 400—650 m. On Mýrdalsjökull the snow-line lies at a height of 1100 m. on the north side, and 800—900 m. on the south side.

Below the snow-line proper comes a zone with snow-drifts which either never melt, the permanent snow-drifts, or only melt in very hot summers, the variable snow-drifts. It is difficult to set any lower limit to these two zones. On Arnarvatnsheiði north-east of Langjökull, where the snow-line lies at a height

of 1000—1100 m., the lower limit of permanent snow-drifts lies at a height of 600—700 m. above sea level, and that of the variable snow-drifts at a height of 500—600 m.

The setting up of climate zones, i. e. of a zone of lowland climate, a zone of highland climate, and various snow zones, results in a similar formation of floristic and vegetation zones to which we shall contribute in the following.

II. CLIMATE AND FLORA.

The above-described rather rigorous climate in connection with the homogeneous soil, consisting of basaltic rocks and their weathering products, is no doubt in great part, and perhaps even more than the isolated position of the island, responsible for the paucity of species apparent in the phanerogams. Thus the most recent treatment of the Icelandic flora, St. Stefánsson's "Flóra Íslands", 2. ed. 1924, gives a total of only 375 phanerogams and vascular cryptogams (the number of species of Taraxacum and Hieracium is, however, taken from the 1st edition of the Flora, 1901).

The floristic peculiarities are here disregarded. They have previously been treated by Grønlund and Warming. Some biological facts are of greater interest in this connection.

In »Flóra Íslands« the country is divided into 5 areas, viz. the East Country or the land between the Langanes Mountains and Hornafjörður; the North Country between the Langanes Mountains and Hrútafjörður; the North West Country or Vestfirðir; the South West Country between Gilsfjörður and the Reykjanes Mountains, and finally the South Country between the Reykjanes Mountains and Hornafjörður. The distribution of each species in each of the aforementioned 5 areas is given in the Flora. By determining the life form of each species and calculating the percentage of the various life forms in the total number of phanerogams we arrive at the biological spectra given in table 3, p. 17, partly for the whole country partly for each of the 5 areas. Of greatest interest are the chamaephytes, the chamaephyte percentage for the whole country being 15.2; hence, as shown by Raunkiær in 1908, Iceland belongs to the subarctic hemicryptophyte-chamaephyte area. For the rest there is a striking, even though slight, difference in the content of chamaephytes in each of the 5 areas. The South Country has a chamaephyte percentage of 15.1, the South West Country has 15.2,

Vestfirðir 16.0, the North Country 16.6, and the East Country 18.0. There is thus an unbroken rise in the chamaephyte percentage from the South Country, whose chamaephyte percentage corresponds to that of the whole country, towards the west and north, until it attains its highest value, 18.0, in the east. It is difficult to ascertain what climatic factor causes this rise, and more probably we may assume that not one but many factors are determining. The physical factor which varies parallelly with the variations in life forms is the annual mean temperature of the oceanic surface water. This as we showed above, was closely correlated to the amount of Gulf Stream water and Polar water at the coasts. The variation in other climatic conditions, whether it be in the air temperature, number of days with frost, the coldest or warmest month, amount of precipitation, number of days with precipitation, days with snow, frost or gales, does not agree nearly so well with the variation in life form as the temperature conditions of the surface water.

The correlation of the biological peculiarities of the flora, more especially of the chamaephyte percentage, and the current conditions of the adjacent seas is likewise confirmed in the surrounding countries. Table 2 gives the biological spectra for West and East Greenland, calculated on the basis of the flora lists given by Ostenfeld (1926).

The west and east coasts of Greenland are each divided into 8 minor corresponding areas. The east coast is washed by a Polar current coming from the north, the Greenland Current, while the west coast is washed by a current coming from the south. In accordance herewith we find that the chamaephyte percentage in the individual, corresponding, minor areas as well as for the two coastal tracts as a whole is highest in the east, lowest in the west. The table shows the composition of the biological spectra. Starting from the number of species, the chamaephyte percentage for the whole of East Greenland is 25.2, for West Greenland 21.6. Starting from the points sum, the ratio will be 28.6 to 25.2. Only South Greenland has a chamaephyte percentage lower than 20, viz. 18.6.

If we pass over to the west coast of Baffin Bay and Davis Strait, we find that a current from the north, the Labrador Current, flows along the eastern coast of Baffin Land, and according to Raunkiær (1908), the chamaephyte percentage for Baffin Land is 30, while for the whole of West Greenland it was only 21.6.

Passing from Iceland towards the east, we find the west coast of Norway washed by the warm Gulf Stream, and here, as a matter

TABLE 2.

The Biological Spectra of West and East Greenland.

		Pt	n	Ph	Ch	H	G	HH	Th[1]
W. Grl. 80°—83° N. Lat.	VIII ...	2.9	69	»	**31.9**	53.6	10.1	4.3	»
76°—80° —	VII ...	5.5	109	»	**31.2**	52.3	11.0	4.6	0.9
71°—76° —	VI ...	5.4	149	»	**30.2**	51.7	12.8	4.0	1.3
69°—71° —	Va ...	5.1	197	»	**27.4**	52.3	11.8	6.1	2.5
Disko	Vb ...	7.5	214	»	**25.7**	53.3	12.1	6.1	2.8
66°—69° —	IV ...	6.0	233	»	**25.8**	51.1	9.9	9.0	4.3
64°—66° —	III ...	7.8	217	0.5	**24.4**	54.8	9.7	7.4	3.2
61°—64° —	II ...	9.3	216	1.4	**21.3**	56.5	8.8	7.4	4.6
S. Grl. 61°—60°—61°	I ...	11.4	236	1.3	**18.6**	54.2	10.6	7.6	7.6
E. Grl. 61°—65° N. Lat.	II ...	9.2	153	»	**22.9**	60.1	9.2	4.6	3.3
Angmagsalik	III ...	9.0	167	»	**24.6**	58.1	8.4	6.0	3.0
67°—70° N. Lat.	IV ...	7.5	120	»	**30.8**	54.2	9.2	4.2	1.7
Scoresby Sound	V ...	6.3	160	»	**29.4**	52.5	12.5	3.8	1.9
72°—76° N. Lat.	VI ...	4.8	126	»	**29.4**	54.0	11.9	2.4	2.4
76°—81° —	VII ...	5.5	91	»	**33.0**	49.5	14.3	3.3	»
81°—83° —	VIII ...	4.3	47	»	**42.6**	44.7	10.6	2,1	»
West Greenland		8.2	352	0.9	**21.6**	54.0	10.5	7.7	5.4
East Greenland		7.1	238	»	**25.2**	57.6	10.0	4.2	2.9
West Greenland..................		7.3	1640	0.4	**25.2**	53.4	10.7	6.7	3.6
East Greenland		7.1	864	»	**28.6**	54.6	10.6	4.1	2.1

of fact, the chamaephyte percentage is considerably lower. According to Raunkiær (1908), Tromsø in 69—70° N. has a chamaephyte percentage of 10, and Vardø, in a still more northerly situation but protected from the sea, has a chamaephyte percentage of c. 15.

It is thus beyond doubt that there is a connection between the biological spectra and the current conditions of the surrounding seas.

For the rest it is probably the temperature conditions which have most influence on the composition on the flora, that is to say, the annual mean temperature or more probably perhaps the temperature conditions of the winter. Passing from the lowlands to the highland, the annual mean temperature, as shown above, grows

[1]) In the tables the abbreviations are as follows: n: number of species, Pt: Pteridophytes, Ph: Phanerophytes, Ch: Chamaephytes, H: Hemicryptophytes, G: Geophytes, HH: Helo- and Hydrophytes and Th: Therophytes.

lower and lower, while the winter grows colder and colder. At the same time the flora shows a greater and greater paucity of species. Unfortunately Stefánsson's "Flóra Íslands" gives no upper limit for the individual species, and as far as Iceland is concerned, only very few authors have stated at what altitudes they have found the plants collected by them. Thoroddsen (1914) has given most in this respect. By comparing what is found in the literature concerning the occurrence of the plants in the highland tracts with my own notes, but especially thanks to a long series of flora lists courteously left at my disposal by Mr. Pálmi Hannesson, I have been able to work out the biological spectra of the highland tracts of Iceland given below, divided into zones of 100 m each, from 300 m to 1200 m, the highest locality in which plants have been found.

While 375 species of vascular plants have been found in the whole country, only 224 species have, up to the present, been found above the 300 m curve, and only c. 100 species above the 600 m curve. Going higher still, we find only 40 species above the 800 m curve, and the number is further reduced when we reach the snow-line above which all higher plant life is excluded. It applies to Iceland as to other arctic regions, the Faeroes, northern Norway and Greenland, that only a limited number of species has any lower limit, while most of the species decrease as we go upward and sooner or later reach their upper limit. The following species are of common occurrence right up to the snow-line: — *Luzula arcuata, Elymus arenarius, Poa glauca, P. alpina, Festuca ovina, Salix glauca, S. herbacea, Oxyria digyna, Cerastium alpinum, Silene acaulis, S. maritima, Ranunculus glacialis, Arabis petræa, A. alpina, Empetrum nigrum, Saxifraga groenlandica, S. oppositifolia, S. nivalis,* and *Armeria vulgaris.* With few exceptions all the above-mentioned species are of common occurrence in Greenland right up into the northern parts.

From considerations of space the species lists are not included. The biological spectra calculated from them are given in table 3. There is a difference in the occurrence of the individual life forms. Some show a decrease as we go upwards, others increase, and others again are constant. The H percentage is fairly constant through all zones, c. 50. Pt, G, HH and Th decrease strongly as we go upward; above the 800 m curve these types have only been noted a few times. With respect to their content of these life forms, various differences may be shown to exist between the various zones, and possibly the highland tracts between 300 and 800 m may by means

TABLE 3. **The Biological Spectra of Iceland.**

	N	Pt	n	Ph	Ch	H	G	HH	Th
11—1200 m	28	3.7	27	»	**44.4**	44.4	7.4	»	3.7
10—1100 -	20	»	20	»	**50.0**	40.0	10.0	»	»
9—1000 -	28	3.7	27	»	**40.7**	51.9	7.4	»	»
8— 900 -	26	»	26	»	**42.3**	50.0	7.7	»	»
7— 800 -	65	3.2	63	»	**36.5**	46.0	12.7	1.6	3.2
6— 700 -	91	2.2	89	»	**29.2**	53.9	11.2	3.4	2.2
5— 600 -	117	4.5	112	»	**25.0**	56.3	8.9	5.4	4.5
4— 500 -	161	5.2	153	0.7	**21.6**	54.9	12.4	5.2	5.2
3— 400 -	204	7.9	189	1.1	**20.1**	51.9	12.2	5.8	9.0
Tvídägra	126	5.0	120	0.8	**25.0**	50.0	12.5	7.5	4.2
Mývatn	166	7.8	154	0.6	**24.0**	46.1	13.6	6.5	9.2
East Iceland	272	6.3	256	0.8	**18.0**	51.2	12.5	7.4	10.2
North Iceland	331	7.5	308	1.0	**16.6**	52.3	11.0	9.1	10.1
Vestfirðir	277	8.2	256	0.8	**16.0**	53.9	12.5	6.6	10.2
SW Iceland	314	8.3	290	0.7	**15.2**	51.4	11.4	9.3	12.1
South Iceland	309	6.2	291	1.0	**15.1**	52.2	11.3	8.9	11.3
The Highland tracts 8—1200	40	5.2	38	»	**34.2**	52.6	10.5	»	2.6
— — — 3— 800	224	7.7	208	1.0	**21.2**	52.9	11.5	5.3	8.2
The whole of Iceland	375	7.4	349	1.1	**15.2**	52.4	10.6	9.2	11.5
The Highland tracts 8—1200	102	2.0	100	»	**44.0**	47.0	8.0	»	1.0
— — — 3— 800	638	5.3	606	0.5	**24.4**	53.1	11.6	4.8	5.6
The whole of Iceland	1503	5.8	1401	0.9	**16.1**	52.2	11.7	8.2	10.8

of these differences be divided into a lower zone rich in G and HH, and an upper zone in which these types grow rarer. Ph are only sparingly represented in the lowest zones. Ch are of the greatest interest. In the lowest zone, between 300 and 400 m, the Ch percentage is 20.1; in the next, 21.6, and henceforth there is a marked increase 25.0—29.2—36.5, until, in the zones above the 800 m curve, we get a Ch percentage varying between 40 and 50 for the individual zones. For the whole highland tract the Ch percentage is 21.2.

By means of the life forms it is thus possible to divide the highland tracts of Iceland into zones delimited and characterised by the percentage content of the individual life forms. It must, however, be reserved for future and more thorough-going investigations to do this as also to draw a comparison between the Icelandic zones on the one hand, and the Scandinavian and Alpine

zones on the other hand. The above-mentioned facts may, however, be utilised to fix one biological line of demarkation in Iceland, viz. *the 20 p. c. Ch biochore.* The lowest zone, the 300—400 m zone, has a Ch percentage of 20.1. The Ch percentage in the lowlands is below 20, and as it is a rule that species decrease in number as we go upward, while only a few or no species are added from above, the 20 p. c. Ch biochore may with fair accuracy be put at the lower limit of the zone, i. e. at c. 300 m above sea level.

If we compare the position of the 20 p. c. Ch biochore in Iceland with the position of this line in other regions, we shall find very good agreement. In Scotland, according to Raunkiær (1908), the 20 p. c. Ch biochore lies at a height of c. 800 m above sea level, and in the Faeroes at c. 500 m. In Greenland only the southernmost part, 61—60° N., lies south of the 20 p. c. Ch biochore. In other words, here the line has come down to sea level. Hence the position in Iceland of the 20 p. c. Ch biochore at an altitude of c. 300 m is in very good agreement with facts in the surrounding countries.

That Ch is the life form best adapted to the Icelandic climate will also appear from the lists in another way. It is clear from the way in which the spectra are calculated that the rarer species will easily come to dominate too much. This error may, however, be rectified by comparing the spectrum formed for a series of zones in the usual way with the spectrum which may be formed from the total of the notes for all zones. Below in table 3 this has been done for Iceland as a whole, for the highland tracts between 300 and 800 m, and for the tracts between 800 and 1200 m. It will appear from the table with all desirable plainness that Ch show the best adaptation, H are indifferent, and Pt, F, HH and Th show the poorest adaptation to the Icelandic climate. The geophytes present interesting facts. In the lowlands they are best adapted to the climate, in the highland tracts between 300 and 800 m they are indifferent, while above the 800 m curve, similarly to H, they thrive badly.

Though we must thus suppose from the above that Raunkiær's life forms would afford a convenient basis even for a more thoroughgoing investigation of the flora and vegetation of Iceland, a classification of the flora according to other viewpoints will always be of interest. Hence I have also divided the flora into groups according to the distribution of the species in Europe and the adjacent arctic

regions. For we cannot take it for granted that a species, because it has come to a certain region, will at once assume the most pronounced life form of the region in question. The dominating life form in arctic regions is Ch, yet we find species with another life form, and these species must be supposed to be just as well adapted to arctic regions as several of the chamaephytes growing there. Conversely, in regions having a hemicryptophyte climate, we may find Ch. A species like *Calluna vulgaris* must be assumed to be just as well adapted to the Danish climate as many hemicryptophytes. Even though Raunkiær's life forms give an excellent biological picture of the climate, they do not give the most accurate picture of it. The distribution of the species must rank first in this respect. However, there must be no disagreement between results obtained by means of Raunkiær's life forms and those obtained by investigations based on the geographical distribution of the species, though at the outset we must expect the latter to give the more pronounced result. Raunkiær's life forms picture the morphological adaptation of the species, the species groups give expression to their physiological adaptation, both, however, express their adaptation to the same life conditions.

Various enquirers in various countries have at different times worked out a classification of the floras of their respective countries. Thus Watson divided the British flora into groups according to the geographical distribution of the species. A. Blytt divided the Norwegian flora on a somewhat similar principle, and various Swedish enquirers, i. a. Gunnar Andersson and H. Hesselman, have classified the Swedish flora. Ostenfeld has classified the flora of the Faeroes, Porsild and Ostenfeld the Greenlandish flora. The principle acted upon by all these enquirers was to separate all species having a pronounced northern or southern distribution from all such as showed an equal distribution over the entire area. This resulted in the first instance in the setting up of three groups, while Watson and Blytt in addition classified the species according as they had a pronounced Atlantic or continental distribution.

An attempt to bring together the species groups of the various authors and thus arrive at a classification of the Icelandic flora proved impossible, since their species groups overlap to such a de-

gree that no satisfactory result was obtainable. I had then no other alternative but to attempt a classification myself. In working out this, an acquaintance with the groups of other authors has of course been of great use to me.

The best way would no doubt be to determine the course of the Ch biochores in the arctic regions and in Europe and next to determine between which biochores the individual Icelandic species most frequently occur, and then classify the flora on the basis of these data. This work I began but had to give it up again as it took so much time that I dared not at the present juncture embark upon it.

The principles which I then adopted, and on which the classification of the flora given below is based, are the following. First I divided the flora into two larger groups A and E, according as the species were of common occurrence in arctic and subarctic regions but were absent or rare in temperate zones (group A), or the species were common in or typical of the more southerly regions (group E). The A group corresponds approximately to the "arctic species", "alpine species", "mountain plants" etc. of the various authors, while the E group corresponds to the "British species", "European species", "Northern species", "Southern species", "Lowland species" etc. The distinction between these two groups does not cause any difficulties, these do not appear until we attempt to subdivide them. In the following the A group is subdivided into three minor groups according to the northern limits of the species, or their ability to withstand cold, in such a way that group 3 extends farthest north or highest up the mountains while group 1 stops first, and group 2 occupies an intermediate position. On the same principle group E is subdivided into 4 minor groups, group 4 including the species occurring farthest north and group 1 those occurring farthest south. The Icelandic flora is thus divided into 7 groups according to the distribution of the species and more precisely according to their "temperature demands".

The distribution of the species has been investigated in the following countries: — Ellesmereland, North Greenland, Spitsbergen, West and East Greenland, Iceland, the Faeroes, Norway, Sweden, Finland, Novaia Zemlia, Ireland, Scotland, England, Denmark, the Baltic States, and north-eastern Germany. The works on the respective floras will be found in the bibliography. — In fig. 1 temperature curves for a series of stations along the western coasts of Greenland and Scandinavia are shown.

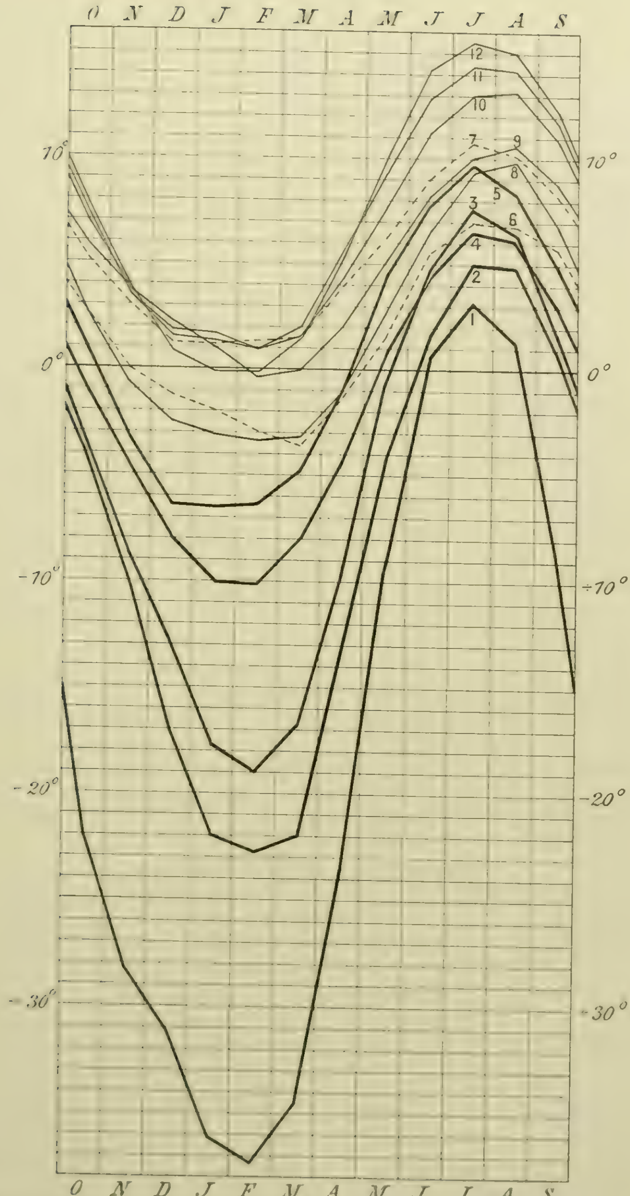


Fig. I. *Temperature Curves for a Series of Stations along the Coasts of W. Greenland, Iceland, and Scandinavia.* From tables in Hann, 1911.

1. North Greenland: 82° N., 63.7° W. 2. Upernivik 72° 47′ N., 55° 53′ W, 12 m. above sea-level. 3. Jakobshavn 69° 13′ N., 50° 55′ W., 13 m. above sea-level. 4. Godthaab 64° 11′ N., 51° 46′ W., 11 m. above sea-level. 5. Ivigtut 61° 12′ N., 48° 11′ W., 5 m. above sea-level.

6. Grimsey, N. Iceland 66° 34′ N., 18° 3′ W., 2.5 m. above sea-level. 7. Vestmannaeyjar, S. Iceland 63° 26′ N., 20° 18′ W., 8 m. above sea-level.

8. Fruholmen 71° 6′ N., 23° 59′ E., 15 m. above sea-level. 9. Skomvaer 67° 24′ N., 11° 54′ E., 20 m. above sea-level. 10. Christianssund, 63° 7′ N., 7° 45′ E., 15 m. above sea-level. 11. Bergen 60° 23′ N., 5° 21′ E., 20 m. above sea-level. 12. Fanø 55° 27′ N., 8° 24′ E., 5 m. above sea-level.

The 7 species groups contain the following species: —

A 3. Arctic species common in North Greenland north of 76°.

H Agropyrum violaceum
Ch Antennaria alpina
Ch Arenaria ciliata
Ch Armeria sibirica
H Campanula uniflora
H Cardamine bellidiflora
H Carex capillaris
H — glareosa
G — incurva
H — nardina
H — pedata
G — rigida
G — rupestris
G — salina
G — saxatilis
H Catabrosa algida
Ch Cerastium alpinum
Ch Draba alpina
Ch — nivalis
Ch Dryas octopetala
H Elyna Bellardi
H Epilobium latifolium
Equisetum variegatum
H Erigeron uniflorus
HH Eriophorum Scheuchzeri
H Juncus biglumis
H — castaneus
H Juncus triglumis
Th Koenigia islandica
H Luzula arcuata
H Mertensia maritima
Ch Minuartia biflora
Ch — verna
H Oxyria digyna
H Papaver radicatum
H Pedicularis flammea
H Poa glauca
G Polygonum viviparum
H Ranunculus glacialis
HH — hyperboreus
H — pygmæus
Ch Sagina intermedia
Ch Salix glauca
Ch — herbacea
H Saxifraga cernua
Ch — groenlandica
H — Hirculus
H — nivalis
Ch — oppositifolia
H — rivularis
H — stellaris
Ch Silene acaulis
Ch Stellaria humifusa
H Trisetum spicatum
Woodsia ilvensis.

A 2. Arctic Species whose Northern Limit in West Greenland lies between 66° and 76° N.

Ch Alchemilla alpina
H — glomerulans
H Arabis alpina
H Archangelica officinalis
H Bartschia alpina
Ch Betula nana
Ch Bryanthus coeruleus
H Carex alpina
H — bicolor
H — brunnescens
H — capitata
G — festiva
H — lagopina
G — microglochin
G — rariflora
Ch Cassiope hypnoides
Ch Cerastium trigynum
G Corallorhiza innata
H Deschampsia alpina
Ch Diapensia lapponica
H Draba incana
H Epilobium anagallidifolium
Th Euphrasia latifolia
Th Gentiana nivalis
Th — serrata
Th — tenella
Ch Gnaphalium supinum
H Hieracium alpinum
G Juncus arcticus
H — trifidus

Ch	Loiseleuria procumbens	Ch	Saxifraga Aizoon
H	Luzula spicata	H	Sedum villosum
	Lycopodium alpinum	Ch	Sibbaldia procumbens
Ch	Minuartia stricta	HH	Sparganium submuticum
H	Phleum alpinum	H	Stellaria borealis
Th	Pleurogyne rotata	H	Taraxacum croceum
H	Poa alpina	H	Thalictrum alpinum
H	Potentilla verna	H	Tofieldia borealis
K	Rhodiola rosea	H	Veronica alpina
Ch	Saxifraga aizoides	Ch	— fruticans

H Viscaria alpina.

A 1. Arctic-Subarctic Species whose Northern Limit in West Greenland lies between 60 and 66° N.

H	Alchemilla acutidens	H	Hieracium arctocerinthe
H	— faeröensis	H	— dovrense
Ch	Arabis petræa	H	— islandicum
	Athyrium alpestre	H	— nigrescens
	Botrychium lanceolatum	H	— prenanthoides
H	Carex atrata	H	— strictum
G	— chordorrhiza		Isoëtes echinospora
HH	— norvegica	G	Juncus balticus
G	— sparsiflora	G	Listera cordata
Ch	Cerastium nigrescens	H	Luzula sudetica
H	Cornus suecica	H	Poa laxa
Ch	Draba rupestris	H	Primula stricta
	Dryopteris lonchitis	Th	Rhinanthus groenlandica
H	Epilobium alsinifolium	Ch	Sagina Linnæi
H	— Hornemanni	Ch	Salix lanata
H	— lactiflorum	Ch	— phylicifolia
H	Erigeron borealis	Ch	Saxifraga Cotyledon
H	Galium trifidum	Ch	— hypnoides
Th	Gentiana aurea	Th	Sedum annuum
H	Gnaphalium norvegicum		Selaginella selaginoides
G	Habenaria viridis	H	Sesleria coerulea
H	Haloscias scoticum	Ch	Silene maritima

H Stellaria crassifolia.

E 4. European Species whose Northern Limit in West Greenland lies north of 66° N.

H	Alchemilla minor	H	Cardamine pratensis
H	Alopecurus aristulatus	H	Carex canescens
HH	Batrachium trichophyllus	G	— dioica
	Botrychium Lunaria	H	Cochlearia officinalis
H	Calamagrostis neglecta	HH	Comarum palustre
HH	Callitriche autumnalis		Cystopteris fragilis
HH	— verna		Dryopteris dilatata
H	Campanula rotundifolia	G	Elymus arenarius

Ch	Empetrum nigrum	G	Poa pratensis
H	Epilobium angustifolium	Th	Polygonum aviculare
	Equisetum arvense	HH	Potamogeton alpinus
G	Eriophorum polystachyum	HH	— filiformis
H	Festuca ovina	HH	— gramineus
H	— rubra	HH	— pusillus
G	Habenaria albida	H	Potentilla anserina
HH	Hippuris vulgaris	H	Puccinellia retroflexa
H	Honckenya peploides	Th	Radicula islandica
H	Juncus supinus	H	Ranunculus acer
Ch	Juniperus communis	H	— reptans
Th	Limosella aquatica	H	Rumex acetosella
	Lycopodium annotinum	HH	Scirpus acicularis
	— selago	H	— cæspitosus
HH	Menyanthes trifoliata	Th	Stellaria media
Th	Montia rivularis	Ch	Thymus serpyllum
HH	Myriophyllum spicatum	H	Triglochin palustre
H	Pinguicula vulgaris	HH	Utricularia minor
H	Pirola minor	Ch	Vaccinium uliginosum
Ch	— secunda	Ch	— vitis idæa
H	Plantago maritima		

E 3. European Species whose Northern Limit in West Greenland lies between 60° and 66° N.

H	Achillea millefolium	G	Habenaria hyperborea
H	Agrostis alba	H	Hieracium murorum
H	— canina	H	Juncus alpinus
H	Anthoxanthum odoratum	Th	— bufonius
Th	Atriplex hastata	G	— filiformis
Ph	Betula pubescens	H	Lathyrus maritimus
HH	Callitriche hamulata	H	Leontodon autumnalis
Th	Capsella bursa pastoris	H	Luzula multiflora
G	Carex Goodenoughii		Lycopodium clavatum
G	— Lyngbyei	H	Matricaria inodora
H	— oederi	HH	Myriophyllum alternifl.
G	— panicea	H	Nardus stricta
HH	— rostrata	Th	Poa annua
H	Catabrosa aquatica	H	— nemoralis
Ch	Cerastium cæspitosum	H	Puccinellia maritima
H	Deschampsia flexuosa	H	Rubus saxatilis
H	Drosera rotundifolia	H	Rumex acetosa
	Dryopteris filix mas	H	— domesticus
	— phegopteris	H	Sagina nodosa
	— pulchella	H	— procumbens
	Equisetum hiemale	G	Scirpus palustris
H	Epilobium palustre	H	— pauciflorus
H	Geranium silvaticum	HH	Sparganium affine
Th	Gnaphalium uliginosum	Th	Subularia aquatica

Ch	Vaccinium oxycoccus	H	Viola palustris
H	Vicia cracca	HH	Zostera marina
H	Viola canina		

E 2. European Species absent from Greenland but without any Northern Limit in Scandinavia.

H	Agrostis tenuis	H	Milium effusum
H	Alopecurus geniculatus	Th	Myosotis arvensis
H	Angelica silvestris	G	Orchis maculatus
H	Aracium paludosum	H	Oxalis acetosella
Ch	Arctostaphylos uva ursi	G	Paris quadrifolia
	Athyrium filix femina	H	Parnassia palustris
Th	Cakile maritima	H	Pirola rotundifolia
Ch	Calluna vulgaris	H	Plantago major
H	Caltha palustris	H	Poa trivialis
G	Carex limosa	Ph	Populus tremula
H	Carum carvi	HH	Potamogeton perfoliatus
H	Deschampsia cæspitosa	H	Ranunculus repens
	Equisetum limosum	Th	Rhinanthus crista galli
	— palustre	Ph	Sorbus aucuparia
	— pratense	Th	Spergula arvensis
Th	Erysimum hieracifolium	H	Spiræa ulmaria
Th	Galeopsis Tetrahit.	H	Taraxacum vulgare
H	Galium boreale	G	Trientalis europæa
H	— uliginosum	H	Trifolium repens
H	Gentiana amarella	H	Triglochin maritimum
H	Geum rivale	H	Urtica dioica
H	Glaux maritima	Th	— urens
H	Hieracium silvaticum	Ch	Vaccinium Myrtillus
G	Hierochloë odorata	Ch	Veronica officinalis
H	Lathyrus palustris	H	— scutellata
Th	Melampyrum silvaticum	H	— serpyllifolia

E 1. European Species with a distinct Northern Limit in Scandinavia.

H	Agropyrum caninum	Th	Crassula aquatica
G	— repens	H	Epilobium collinum
H	Anthyllis vulneraria	Th	Erophila verna
H	Avena elatior	H	Festuca pratensis
	Blechnum spicant	H	Fragaria vesca
H	Brunella vulgaris	H	Galium silvestre
HH	Callitriche stagnalis	H	— verum
Th	Cardamine hirsuta	H	Gentiana campestris
H	— silvatica	HH	Glyceria fluitans
G	Carex glauca	H	Gnaphalium silvaticum
H	— paniculata	H	Hieracium Schmidtii
H	— pilulifera	H	Hydrocotyle vulgaris
G	Cirsium arvense	H	Juncus lamprocarpus

H	Knautia arvensis	Th	Polygonum persicaria
Th	Lamium intermedium	HH	Potamogeton natans
H	Lathyrus pratensis	Ph	Rosa canina
Th	Linum catharticum	Ch	— spinossissima
G	Listera ovata	HH	Ruppia maritima
H	Litorella uniflora	H	Sagina subulata
H	Lychnis flos cuculi	H	Sangvisorba officinalis
Th	Myosotis hispida	Ch	Sedum acre
Th	— micrantha	Th	Senecio vulgaris
Th	— versicolor	Th	Sisymbrium sophia
HH	Myriophyllum verticillatum	HH	Sparganium minimum
	Ophioglossum vulgatum	H	Succisa pratensis
G	Orchis latifolius	H	Valeriana officinalis
H	Phleum pratense	HH	Veronica anagallis
H	Plantago lanceolata	H	Vicia sepium
	Polypodium vulgare	H	Viola silvestris
HH	Polygonum amphibium	Th	— tricolor

HH Zannichellia palustris.

On the basis of particulars as to the proportion of each species in the floras of the above-mentioned countries, the Icelandic species were referred to one of the 7 species groups. While it is comparatively easy to place the species in the A or E groups, as this is only a question of ascertaining whether the main distribution of the species is above or below, north or south of three limits, the 20 % Ch biochore, a subdivision at the outset necessitates the selection of a parallel of latitude, to the north of which the species do not occur. At each species group is stated the parallel of latitude selected as the upper limit of the species. In order to gain a comprehensive view of the extent to which it has been possible to gather the species into groups expressing adaptation to the arctic climate, the following conditions have been reviewed: — 1) The presence of the species groups in the floras of the different countries, 2) the distribution of the groups in Iceland, and 3) the content of Raunkiær's life forms in each group.

I. In table 4 are given the individual countries examined, beginning with those that are most arctic in character, as Ellesmereland, North Greenland, and Spitsbergen, and ending with the most temperate. In the first column is stated the number of species which the country in question has in common with Iceland. The next two columns state how many of these species, common to both, belong to the A- and E-groups, and the last columns give particulars of the sub-groups.

TABLE 4.

Distribution of the Species Groups in Northern Europe and the Arctic Regions.

	n	A	E	A 3	A 2	A 1	E 4	E 3	E 2	E 1
Ellesmereland	55	45	10	43	2	»	10	»	»	»
North Greenland 76°—83°—76°	66	51	15	51	»	»	15	»		»
Spitsbergen	53	43	10	43	»	»	10	»	»	»
West Greenland 66°—76°	170	111	59	55	50	6	57	2	»	»
East Greenland 60°—76°	177	117	60	53	46	18	44	15	»	1
Novaia Zemlia	72	51	21	36	12	3	17	2	2	»
South-West Greenland 60°—66°	228	121	107	50	49	22	53	53	1	
Iceland	375	151	224	55	51	45	57	53	53	61
The Faeroes	219	73	146	27	21	25	45	38	29	34
Norway	367	144	223	54	50	40	57	52	53	61
Sweden	363	141	222	52	49	40	57	51	53	61
Finland	344	132	212	52	45	35	57	50	53	52
Scotland	304	86	218	28	32	26	56	50	52	60
Iceland	243	36	207	14	8	14	52	49	48	58
England	231	20	211	8	5	7	53	49	51	58
Denmark	238	17	221	5	2	10	57	51	53	60
The Baltic States	231	20	211	6	5	9	53	50	53	55
North-East Germany	231	15	216	3	3	9	55	50	53	58

In the countries north of Iceland it is especially the A species which constitute the greater part of the common species, and the farther north we go, the more numerous are the A 3 species.

In the countries south of Iceland the reverse is the case; here comparatively the greatest number of the common species belongs to the E groups. In Scandinavia and Finland the proportion of the A groups to the E groups is approximately as in Iceland.

The table shows the distribution of the species groups illustrated exclusively by the quantitative relation of the species to each other. The facts relating to the distribution would, however, appear much more distinctly if the frequency of the species in the separate countries were taken into account, and a classification were worked out for Scandinavia.

II. The Distribution of the Species Groups in Iceland.

Below in table 5 the quantitative relation between the species groups has been calculated in per cent partly of the number of

TABEL 5. **Distribution of the Species Groups in Iceland.**

	n	A	E	A3	A2	A1	E4	E3	E2	E1
11—1200 m................	28	**78.6**	21.4	57.1	10.7	10.7	17.9	3.6	»	»
10—1100 -	20	**85.0**	15.0	65.0	10.0	10.0	15.0	»	»	»
9—1000 -	28	**82.1**	17.9	57.1	14.3	10.7	14.3	3.6	»	»
8— 900 -	26	**88.5**	11.5	65.4	11.5	11.5	11.5	»	»	»
7— 800 -	65	**80.0**	20.0	44.6	24.6	10.8	18.5	1.5	»	»
6— 700 -	91	**73.6**	26.4	35.2	25.3	13.2	20.9	4.4	1.1	»
5— 600 -	117	**69.2**	30.8	29.1	28.2	12.0	19.7	6.8	3.4	0.9
4— 500 -	161	**59.6**	40.4	23.6	24.8	11.2	18.6	13.0	7.5	1.2
3— 400 -	204	**49.5**	50.5	19.6	20.1	9.8	18.6	15.2	13.7	2.9
Tvidægra	126	57.9	42.1	21.4	25.4	11.1	21.4	14.3	5.6	0.8
Mývatn	166	50.6	49.4	18.7	20.4	11.4	19.3	16.3	11.4	2.4
East Iceland	272	45.2	54.8	16.5	17.3	11.4	16.9	17.3	13.2	7.4
North Iceland..............	331	44.4	55.6	16.3	15.1	13.0	17.2	15.1	13.0	10.3
Vestfirðir..................	277	43.7	56.3	15.5	15.9	12.3	18.1	16.6	14.4	7.2
South-West Iceland	314	40.4	59.6	13.7	14.3	12.4	16.9	16.2	14.0	12.4
South Iceland..............	309	39.2	60.8	13.9	13.9	11.3	17.2	15.5	13.9	14.2
The highland tracts 8—1200 m	40	**80.0**	20.0	**57.5**	12.5	10.0	15.0	5.0	»	»
— — — 3— 800 -	224	**51.8**	**48.2**	20.1	**20.5**	11.2	**17.4**	**15.2**	12.9	2.7
The whole of Iceland	375	40.3	**59.7**	14.6	13.6	**12.0**	15.2	14.1	**14.1**	**16.3**
The highland tracts 8—1200 m	102	**83.3**	16.7	**60.8**	11.8	10.8	14.7	2.0	»	»
— — — 3— 800 -	638	**62.2**	37.8	27.1	**24.0**	11.1	**19.1**	10.2	7.1	1.4
The whole of Iceland	1503	42.5	**57.5**	15.2	15.2	**12.1**	17.2	**16.1**	**13.7**	**10.4**

species, partly of the number of points 1) for the whole of Iceland, which means, practically, for the lowlands of Iceland, 2) for the highland tracts between the 300 and 800 m curves, and, finally, 3) for the highland tracts between the 800 and 1200 m curves. It appears from the table with all desirable plainness that the A group is best adapted to Icelandic conditions, considerably better than the E group. This is evident both from the values computed from the species figures and those computed from the points, but it is especially evident on comparison between the percentages within the same altitude group.

If, next, we consider the subgroups, the table shows a gradual adaptation to arctic conditions. E 2 and especially E 1 show the poorest adaptation, not even the lowlands seem to offer favourable conditions for the species of these two groups. E 3 thrives well here,

TABLE 6.

Quantitative Distribution of the Species Groups in Iceland.

		The entire flora	A	E	A 3	A 2	A 1	E 4	E 3	E 2	E 1
number of species ..	....	375	151	224	55	51	45	57	53	53	61
East Iceland........	absent	27.5	18.6	33.5	18.2	7.8	31.1	19.3	11.3	32.1	67.2
	scattered-rare	27.5	25.8	28.5	27.3	23.5	26.7	15.8	35.9	37.8	26.3
	common	45.1	55.6	38.0	54.5	68.6	42.2	64.9	52.8	30.2	6.6
North Iceland	absent	11.7	2.6	17.9	1.8	2.0	4.4	»	5.7	18.9	44.3
	scattered-rare	40.8	37.1	43.3	40.0	25.4	46.6	36.8	37.7	49.1	49 7
	common	47.5	60.3	38.8	58.2	72.6	48.9	63.1	56.6	32.1	6.6
North-West Iceland .	absent	26.1	19.9	30.4	21.8	13.7	24.4	12.3	13.2	24.5	67.2
	scattered-rare	32.0	28.5	34.4	23.7	25.5	37.7	26.3	35.8	49.1	27.9
	common	41.9	51.7	35.3	54.5	60.8	37.8	61.4	51.0	26.4	5.0
South-West Iceland .	absent	16.3	15.9	16.5	21.8	11.8	13.3	7 0	3.8	17.0	36.1
	scattered-rare	37.3	30.5	42 0	23.7	23.6	46.7	28.1	37.7	45.3	55.7
	common	46.4	53.6	41.5	54.5	64.7	40.0	64.9	58.5	37.7	8.2
South Iceland	absent	17.6	19.9	16.1	21.8	15.7	22.2	7.0	9.4	18.9	27.9
	scattered-rare	37.3	27.8	43.8	23.7	23.6	37.8	33.3	39.6	45.3	55.7
	common	45.1	52.3	40.2	54.5	60.8	40.0	59.6	51.0	35.9	16.4
Average	absent	19.8	15.4	22.9	17.1	10.2	19.1	9.1	8.7	22.3	**48.5**
	scattered-rare	35.0	30.0	38.4	27.7	24.3	39.1	28.1	37.3	**45.3**	42.9
	common	45.2	54.7	38.8	55.2	**65.5**	41.8	**62.8**	**54.0**	32.5	8.6

but conditions even in the lower areas of the highland tracts are unfavourable to this group. For E 4 this is not the case until we reach the upper areas of the highlands. In the lower highland tracts this group even seems to thrive better than in the lowlands. The same is the case with the subgroups of A. A 1 is mainly indifferent though it occurs most frequently in the lowlands, A 2 exhibits the highest percentage in the lower highland tracts, but in any case finds the upper highland tracts unfavourable, while A 3 shows the absolutely highest percentage in that area.

Between A 3 as one extreme and E 1 as the other the remaining groups show a fairly smooth gradation.

In Stefán Stefánsson's »Flóra Íslands« it is stated for each species with what degree of commonness it occurs in each of the 5 parts

of the country E., N., N. W., S. W., and S. Iceland. The designation algeng, hjer & hvar, or sjaldgæf after each species denotes whether the species is common, scattered or rare. For each of the 5 parts of the country have been added up the species of the respective groups 1) which are absent, 2) which are scattered to rare or 3) which are common within the area. The investigation has been carried out for the flora as a whole, for the main groups, A and E, and for the subgroups under these two groups, and the result expressed in percent of the species number of the group in question has been given in table 6. The means for all parts of the country are given below in the table. The A group has more common species, less rare or absent species than the E group; while on an average 15,4 p. c. of the species of the A group are absent in each part of the country, the same figure for the E group is 22,9 p. c. For the commonly occurring species the proportion of A to E is as 54.7 to 38.8.

If next we turn to the subgroups, the table shows that A 2 has the greatest number of common species, while A 3 and especially A 1 show a smaller number. Of the E subgroups, E 4 has the greatest number of common species, 62,8 p. c., E 1 the smallest number, 8,6 p. c. E 3 and E 2 occupy an intermediate position with 54,0 p. c. and 32.5 p. c. respectively of common species. The numerical values for the rarer and absent species entirely confirm the sequence. In addition the table shows the quantitative conditions of the flora and species groups in the 5 Icelandic areas. The A group occurs most frequently to the east and north, the E group to the south and south-west. In the A group this is due especially to A 2, in the E group, to E 2 and E 1.

Aided by the above-mentioned tables we can now give the following description of the distribution of the Icelandic species groups in northern Europe and the arctic regions.

The E group comprises species of common occurrence in Central Europe. The species have their main distribution to the south of or below the forest limit, the 20 p. c. Ch biochore. The various species, however, transcend this limit in varying degree in consequence of which the following 4 subgroups may be distinguished.

E 1 requires the greatest amount of heat. In England, Denmark, northern Germany, and southern Scandinavia the E 1 species are of common occurrence. In Finland they only occur in the most southerly part, in northern Scandinavia only or principally on shel-

tered sunny slopes. In Iceland most of the E 1 species are rare, they only occur in the lowlands especially towards the south, and thrive best near the hot springs.

E 2. Like the E 1 species, the species of this group are restricted to the lowlands in Iceland, and occur more commonly south of than north of the »jökull line«. However, these species occur more commonly than the species of the previous group. In Scandinavia and Finland they extend right up to the northern coasts, but none of them have reached Greenland.

E 3. Like E 2 the species of this group have no northern limit in Scandinavia and Finland. In Iceland they are common lowland species which still thrive well in the lower zone of the highlands but disappear higher up; they occur commonly and with equal frequency in the various parts of the country. The species are found in South Greenland as pronounced southern types. 66° N. has been chosen as the northern limit of the group in West Greenland.

E 4 is the subgroup which has most common species in Iceland, and the species are of common occurrence right up into the upper zone of the highland tracts. In Greenland, too, the species are of common occurrence, some species even extend right up into North Greenland.

The A group comprises arctic and subarctic species having their main distribution near, north of, or above the forest limit, the 20 % Ch biochore. The species are common in Greenland, Spitsbergen, Iceland, and on the Scandinavian and Scotch mountains. In more southerly countries the species are either absent (and this applies to the majority), or they occur sporadically and in small quantity.

A 3 comprises the species which extend farthest north in the arctic region and are therefore capable of withstanding the severest cold. In Scandinavia these species are confined to the most markedly arctic localities; in Iceland they are a characteristic feature of the upper highland zone.

A 2 comprises most of the common species of the A groups in Iceland. The species of this group are more in evidence north of than south of the "jökull line" and seem to thrive better in the lower highland tracts than above and below. In Greenland these species are of common occurrence though they do not, like the A 3 species, extend into North Greenland.

A 1 comprises such species as must be termed arctic though they do not extend very far north in Greenland. Their northern limit in West Greenland lies south of 66° N. In Iceland the species are equally distributed through all altitude zones, though with a slight maximum in the lowlands. The A 1 species occur most commonly north of the "jökull line", especially in North Iceland.

III. Investigation of the distribution of the species, partly in the North European and the adjacent arctic countries, and partly in Iceland, gave the result that the 7 subgroups show a fairly smooth gradation from A 3, which is adapted to the coldest conditions, to E 1, which requires the greatest amount of heat. The increasing adaption to arctic conditions may, however, be demonstrated in another way, too, viz. by a comparison of the individual groups with respect to their content of Raunkiær's life forms. If the groups and subgroups express an increasing degree of adaption to the arctic climate, this must appear by the fact that that group or those groups which are best adapted to the arctic climate shows or show the greatest content of arctic life forms and fewest temperate life forms, whereas the reverse must be the case with the remaining groups.

Against each species in the above list is given the life form of the species in question, and in table 7 are stated the biological spectra of the groups.

According to Raunkiær (1908, 1912), Ch is the life form which is best adapted to the arctic climate, while H and G are indifferent, and Ph, HH, and Th are adapted to non-arctic conditions. By comparison of the biological spectra of the A and E groups with the spectrum of the entire flora, it will be seen that the A group is more arctic in character, the E group more temperate in character than the flora as a whole. The subgroups under A and E bear the same relation to their respective main groups as these to the whole flora. The high HH percentage in E 4 and partly also in E 1 is however, worth noting.

On reviewing the biological spectra of the various parts and zones of Iceland we saw that the Ch % was lowest (15 %) in the south country where the amount of warm water at the coasts was greatest, that it then rose gradually as the amount of Polar water

TABLE 7. **The Biological Spectra of the Species Groups.**

	Pt	n	Ph	Ch	H	G	HH	Th
The whole flora.........	7.4	349	1.1	15.2	52.4	10.6	9.2	11.5
A-Group................	5.6	143	»	**26.6**	53.1	11.2	2.8	6.3
E-Group................	8.7	206	1.9	7.3	51.9	10.2	**13.6**	**15.0**
A 3....................	3.8	53	»	30.2	52.8	11.3	3.8	1.9
A 2....................	4.0	50	»	26.0	52.0	10.0	2.0	10.0
A 1....................	12.5	40	»	22.5	55.0	12.5	2.5	7.5
E 4....................	11.8	51	»	11.8	43.1	9.8	**25.5**	9.8
E 3....................	10.4	48	2.1	6.3	56.3	12.5	10.4	12.5
E 2....................	8.2	49	4.1	8.2	59.2	10.2	2.0	**16.3**
E 1....................	5.2	58	1.7	3.4	50.0	8.6	**15.5**	**20.7**

at the coasts increased, and the amount of Gulf Stream water decreased, towards the west and north, until it reached its highest value, 18 p. c. in East Iceland, at the same time as the Polar water became prevalent at the coast. This was the result round the entire coast, and on passing from the level of the sea towards the snow-line the Ch. percentage rose very greatly, from c. 20 p. c. at the 300 m curve to c. 50 p. c. at the snow-line, the 1200 m curve.

If we examine the relations of the species groups under the same conditions, as done in table 5, we find a very close correspondence between the A percentage and the Ch percentage. If we proceed in the same way round the coast from South Iceland via W. and N. to East Iceland, the A percentage shows an unbroken rise from 39.2 p. c. in South Iceland, to 45.2 p. c. in East Iceland, and if we pass from the sea to the snow-line, the same fact appears. The A percentage for the whole country is 40.3, at the 300 m curve it is 49.5, rising to 80 at the snow-line. The table likewise shows the relations of the subgroups. The 20 p. c. Ch biochore seems to coincide with the 50 p. c. A biochore.

Raunkiær's life forms and the phytogeographical species groups thus react similarly to the same external conditions. The species groups are, however, more sensitive than the life forms.

III. TYPES OF ICELANDIC VEGETATION.

The types of the Icelandic vegetation, their floristic composition, and their distribution in the various parts of Iceland have been treated in a series of works by Chr. Grønlund (1887 and 1884), St. Stefánsson (1895), Helgi Jónsson (1895, 1900, 1905 and 1913), C. H. Ostenfeld (1899 and 1905), Th. Thoroddsen (1914), and Ingimar Óskarsson (1927).

In "The Botany of Iceland" 1914, pp. 317—343, Thoroddsen gives a general view of the types of Icelandic vegetation, attaching to each type a brief discussion of its floristic peculiarities.

According to this the types of vegetation occurring in Iceland are the following:

1. The Vegetation of the Coast Line. a. Rock vegetation, b. fowling cliff vegetation, c. sand strand vegetation, d. salt-marsh vegetation.
2. The Vegetation of Fresh Water. a. Vegetation of running water, b. of lakes and pools.
3. The Vegetation around Springs (the Dý Vegetation).
4. The Vegetation around Hot Springs. a. Around hot alkaline springs, b. around the solfataras.
5. The Vegetation on Wet Soil. a. Mýri vegetation, b. flói vegetation.
6. The Vegetation on Rocky Flats. a. On gravelly flats (melar), b. stone-covered ridges (holt), c. river gravel (urd), d. rocky boulders (hamrar), e. (eyrar), f. clayey flats (flag).
7. The Vegetation of the Mountain Slopes. Under this head come the herb slope and the herb flats.
8. Psammophilous Vegetations. a. Sand-covered tracts (sandar), b. blown sand (dunes).
9. The Vegetation of the Lava Streams; in various stages of development.

10. The Grimmia Heath Vegetation.
11. Grassland. a. Grass slopes, b. knolly grassland (græsmo), c. dry uncultivated grassland without knolls (valllendi), d. the homefield ú(tn).
12. Heather Moors.
13. Willow Copses.
14. Birch Copses and Birch Forests.

The principles on which the above classification has been based take account partly of environment and partly of purely physiognomic features. If, however, a biological point of view is adopted, it will be natural to continue according to the principles employed above in the division of the Icelandic zones of altitude.

In Ingimar Óskarsson's paper on the vegetation and flora in Vestfirðir all the species noted are given under each type of vegetation, and for each species its upper and lower limit. Table 8 below has been worked up from these data and gives both the spectra of the species groups and the biological spectra of the individual altitudinal zones for the whole area and, finally, for the individual types of vegetation.

With regard to the altitudinal zones the table shows a steady decrease in the number of species from below upwards. The biological spectra show a H percentage which is practically constant throughout all zones, but a steadily increasing Ch percentage and steadily decreasing Th, HH, and G percentages from the lower towards the upper zones. The corresponding change in the spectra of the species groups is an increasing excess of A, especially A 3, species, and a steady decrease of E species, the E 1 species disappearing first, the E 4 species last. All these facts are thus in close agreement with those stated for the whole country. — Only the position of the 20 p. c. Ch biochore forms an exception since it lies considerably lower here.

The vegetation spectra have apparently a very variegated appearance. It is, however, possible to combine them to form several characteristic groups. Thus one group comprises the series melar — mo — herb flat, in which the melar vegetation has the highest A percentage and the lowest E percentage. The reverse is the case with the herb flats, while the mo occupies an intermediate position.

Another group consists of the melar — mo — mýri and freshwater vegetations. Here the difference is that the melar has the

Table 8.

Species Group Spectra and Biological Spectra of the Altitudinal Zones and Types of Vegetation in Vestfirðir

(based on Ingimar Óskarsson's lists of species (1927).

	n	A	E	A3	A2	A1	E4	E3	E2	E1	Ph	Ch	H	G	HH	Th
4—500 m	14	**93**	7	50	43	»	7	»	»	»	»	**43**	50	7	»	»
3—400 -	35	**89**	11	52	34	3	9	3	»	»	»	**43**	46	9	3	»
2—300 -	74	**68**	32	27	27	14	16	14	3	»	»	**31**	51	14	4	»
1—200 -	112	**51**	**49**	21	19	12	22	17	8	2	1	**24**	46	15	8	5
0—100 -	191	41	**59**	15	14	12	21	19	14	5	1	17	52	15	6	9
The entire area..	212	44	56	16	16	11	19	18	13	5	1	18	52	14	7	8
Highland melar..	45	**82**	18	42	31	9	13	4	»	»	»	**40**	49	11	»	»
Dwarf willow veg.	27	**70**	30	22	41	7	19	4	7	»	»	**30**	52	19	»	»
Lowland melar ..	82	**60**	40	22	23	15	17	12	5	6	1	**34**	54	9	»	2
Heath vegetation.	80	**49**	**51**	11	23	15	20	18	11	3	3	**25**	**54**	18	»	1
Mo vegetation ...	73	**51**	49	15	25	11	18	19	8	4	»	**22**	**56**	14	»	8
Mýri vegetation..	69	**49**	**51**	19	19	12	25	15	10	2	»	10	**52**	**25**	9	4
Littoral meadow.	20	**50**	**50**	**35**	5	10	25	25	»	»	»	10	**60**	15	»	**15**
Grass-field veg. ..	57	30	**70**	7	11	12	18	25	19	9	»	12	**60**	12	»	**16**
Herb-field	31	32	**68**	10	23	»	23	26	16	3	»	19	**61**	16	»	3
Birch copse	47	23	**77**	4	11	9	26	28	21	2	4	21	40	30	»	4
Freshwater veg...	13	8	**92**	»	8	»	**54**	31	8	»	»	»	15	15	**70**	»
Hot springs	12	»	**100**	»	»	»	25	**42**	8	**25**	»	»	**67**	8	»	**25**

highest Ch percentage, the mo the highest H percentage, the mýri the highest G percentage, and the freshwater vegetation the highest HH percentage.

A third group is formed by the littoral vegetation, the grassfield vegetation, and the vegetation of the hot springs. These three types of vegetation are all characterised by a high H percentage and, in proportion to the other types of vegetation and to the area as a whole, an unusually high Th percentage. In the species group spectra, however, they differ essentially.

Between the freshwater vegetation and the vegetation of the hot springs which both show an unusually high E percentage, there is a striking difference in the spectra of the E subgroups, the freshwater vegetation having its maximum in E 4 and the vegetation of the hot springs in E 3. The deviation is, however, greatest in E 1

where the freshwater vegetation is not represented at all, while the hot springs have another maximum here.

In a subsequent chapter I shall return to the vegetation spectra given in table 8. In this connection it will suffice to point out that it is probably the same forces, viz. differences of temperature, which have been active in the formation of the Icelandic types of vegetation which have determined the floristic differences of the altitudinal zones.

The factors especially causing differences of temperature in a given area of Iceland are partly differences with respect to the amount of snow and partly differences with respect to the amount of water. Hence the first task of an analyst of plant formations, after an examination of the vegetation at various heights above sea level, will be to investigate the influence on distribution of these two factors, and by this means attempt a grouping of the Icelandic types of vegetation.

In the two succeeding chapters I shall therefore give a more detailed account of the results I arrived at on analysing the formations on a journey in Iceland in the summer of 1925. In yet another chapter the influence on the vegetation of differences in snow-covering and the moisture of the soil will be more thoroughly discussed, and finally the results thus gained will be utilised in setting up the types of Icelandic vegetation which have, up to the present, been more thoroughly investigated.

An analytical study of the formations has hitherto been carried out in 4 different places in Iceland, viz. on Lýngdalsheiði in Árnesssýsla in the south country, partly at c. 100 m above sea level, and further at c. 250—300 m and c. 400 m above sea level; on Arnarvatnsheiði near Úlfsvatn in the highlands northwest of Langjökull at c. 500 m above sea level; in the valley bottom at Lækjamót in Viðidalur in the north country, and in the valley bottom at Norðtunga in Borgarfjörður in the south-west country.

The investigation was carried out by means of Raunkiær's circling method. With a few exceptions, 25 random samples from each locality, each of $^{1}/_{10}$ sq. m., were analysed. I have not thought it appropriate to take into account other methods of analysis, partly because those which could here be considered are of a later date than Raunkiær's circling method and to a certain extent resemble it, partly because, from a scientific point of view, they must be regarded as retrograde. Up to the present, Raunkiær's circling

method is the only method for investigation of the vegetation which, in determining the quantitative distribution of the individual species, makes use of the flora list principle, a principle which has always formed the basis of scientific plant geography, and which must also be adopted in the doctrine of formations if this branch of botany is to lay claim to scientific equality with the other phytogeographical branches of the science.

In naming the individual types of vegetation, I have used the Icelandic names and thus adhered to a custom often adopted in plant geography, that of retaining old names where such were found. At the same time reference of my own more thoroughly investigated types to the previous, more diffusely treated types of vegetation has been avoided, and this is in so far fortunate as it would seem that the latter have been determined with more regard to their physiognomy than to their environment. On the whole, however, the boundary lines coincide. Some of the names have already been used by Helgi Jónsson (1895); for those which do not occur in his paper I am indebted to the courtesy of Icelandic farmers or to Magister Pálmi Hannesson.

IV. THE ICELANDIC LOWLAND FORMATIONS.

A. LÝNGDALSHEIÐI.

If from some elevated point, say Hrólfshólar or Thrasaborgir, (cfr. figs. 2 & 3) we try to get a general idea of the vegetation on Lýngdalsheiði, it will, at that distance, appear to us as an immense monotonous greyish green carpet sprinkled with smaller or larger patches of a yellowish or vivid green colour. These three shades of colour answer to the three most widespread types of vegetation on Lýngdalsheiði, viz. the mo, which forms the bulk of the vegetation, the Grimmia heath, mosathembur, which covers the more prominent parts of the landscape as a yellowish carpet, and the snow patches, geiri, which form fresh green oases in the shelter of slopes and hills or in the old beds of rivulets.

This is how the landscape appears in the vegetation period. Earlier in the year, e. g. at the close of the period when the snow melts, the mo and mosathembur vegetations have their natural colour, while the snow still covers the geiri vegetation. In winter the mo as well as the geiri vegetation are covered with snow, while the mosathembur vegetation is bare.

Of less importance than these three types are a few other vegetation types. Where there is a strong wind on the steeper parts, the vegetation and the layer of mould blow away and leave a soil covered with stones and gravel which forms the starting point for the melar vegetation. On the numerous small cones deposited by the little streams of melting snow, especially in Lyngdalen, but also on the flat parts ot the volcanic shield we find the valllendi vegetation, and on areas not sufficiently drained there occurs the mýri vegetation.

In the following we shall subject these 6 types of vegetation to a closer analysis.

The Mosathembur Vegetation. Cf. fig. 4, and table 9 A-B.

On the more prominent parts of Lýngdalsheiði, from which the snow is at once swept away by the wind in the winter, we find the mosathembur vegetation developed. Even a long distance off this type of vegetation is easily recognisable by its yellowish hue. This colour is due to *Grimmia hypnoides* which covers the surface in a dense and deep elastic carpet. When the Grimmia heath is sufficiently large, the moss carpet is, as it were, split up into large tablets separated by systems of lines; the lines of one system as a rule converge towards a point in the lower edge of the moss carpet, another system forming larger or smaller angles with the first one. These lines do not extend into the surrounding mo, there we find the usual knoll formation.

Table 9 A gives the circling results of the phanerogamous flora of the mosathembur vegetation. The five first columns represent

Table 9 a.

The Mosathembur Vegetation on Lýngdalsheiði.

1—5 Localities in Lýngdalur, c. 200 m above sea level, $^{2}/_{7}$ 1925. 6—10. Hrólfshólar 280—320 m above sea level, $^{1}/_{7}$ 1925. 11 Thrasaborgir, c. 400 m above sea level, $^{23}/_{7}$ 1925. (25. $^{1}/_{10}$ m^{2})

			1	2	3	4	5	6	7	8	9	10	11
Carex rigida	A 3	G	**96**	**88**	**84**	**96**	**96**	48	36	**56**	44	24	32
Salix herbacea	A 3	Ch	»	24	4	4	40	**100**	**92**	**100**	**100**	**100**	**80**
Festuca rubra	E 4	H	**56**	28	44	**56**	**56**	»	»	28	»	»	»
Thalictrum alpinum	A 2	H	**72**	20	36	28	48	»	»	24	4	28	»
Polygonum viviparum	A 3	G	8	20	12	»	28	32	28	32	36	48	8
Equisetum pratense	E 2	G	4	16	»	20	8	»	»	28	8	4	»
Armeria vulgaris	A 3	Ch	»	4	4	8	4	4	8	20	16	12	»
Silene acaulis	A 3	Ch	»	4	»	»	12	4	4	8	16	20	»
Empetrum nigrum	E 4	Ch	»	»	»	»	8	8	8	8	12	8	»
Juncus trifidus	A 2	H	»	»	»	»	4	4	8	»	8	4	»
Galium Normanni	A 1	H	8	4	»	»	12	»	»	»	»	»	»
Cerastium alpinum	A 3	Ch	8	4	»	»	12	4	»	»	4	»	»
Festuca ovina	E 4	H	»	»	4	»	»	4	»	»	4	4	»
Loiseleuria procumbens	A 2	Ch	»	»	»	»	»	»	»	»	4	»	»
Luzula spicata	A 2	H	»	»	»	»	12	»	»	»	8	4	»
Vaccinium uliginosum	E 4	Ch	»	»	»	»	»	»	»	»	4	»	»
Equisetum variegatum	A 3	H	16	»	»	»	»	»	»	»	»	»	»
Rumex acetosa	E 3	H	»	»	4	»	»	»	»	»	»	»	»
Agrostis canina	E 3	H	»	»	»	»	4	»	»	»	»	»	»

Table 9 b.

Biological Spectra of the Mosathembur Vegetation.

1—11 correspond to 1—11 in table 9 A.

	1	2	3	4	5	6	7	8	9	10	11
Points sum	268	212	192	212	344	208	184	304	268	256	120
Number of species	8	10	8	6	14	9	7	9	14	11	3
Density of species	2.7	2.1	1.9	2.1	3.4	2.1	1.8	3.0	2.7	2.6	1.2
A	**77.6**	**79.2**	**72.9**	**64.2**	**77.9**	**94.2**	**95.7**	**78.9**	**89.6**	**93.8**	**100.0**
E	22.4	20.8	27.1	35.8	22.1	5.8	4.3	21.1	10.4	6.3	0.0
A 3	**47.8**	**67.9**	**54.2**	**50.9**	**55.8**	**92.3**	**91.3**	**71.1**	**80.6**	**79.7**	**100.0**
A 2	26.9	9.4	18.8	13.2	18.6	1.9	4.3	7.9	9.0	14.1	
A 1	3.0	1.9	»	»	3.5	»	»	»	»		
E 4	20.9	13.2	25.0	26.4	18.6	5.8	4.3	11.8	7.5	4.7	»
E 3	»	»	»	»	1.2	»	»	»	»	»	»
E 2	1.5	7.5	2.1	9.4	2.4	»	»	9.2	3.0	1.6	
E 1	»	»	»	»	»	»	»	»	»	»	»
Ch	3.0	17.0	4.2	5.7	22.1	**57.7**	**60.9**	**44.7**	**58.2**	**54.7**	**66.7**
H	**56.7**	**24.5**	**45.8**	**39.6**	**39.5**	3.8	4.3	17.1	9.0	15.6	»
G	**40.3**	**58.5**	**50.0**	**54.7**	**38.4**	**38.5**	**34.8**	**38.2**	**32.8**	**29.7**	**33.3**
HH	»	»	»	»	»	»	»	»	»	»	»
Th	»	»	»	»	»	»	»	»	»	»	»

mosathembur in Lýngdalur c. 200 m above sea level, 6—10 that of Hrólfshólar c. 300 m above sea level, and No. 11 that of Thrasaborgir at a level of 400 m.

The phanerogamous vegetation is poor in species and open. In 2.5 sq. m on an average c. 10 species will occur with a density of 2—3.

Biologically the mosathembur vegetation is remarkable by its high percentage of arctic, particularly high arctic, species, and more especially by its high G percentage.

In Lýngdalur, cf. Nos. 1—5, it is H and G that predominate, while Ch is of minor importance. Here the dominant species are *Carex rigida, Polygonum viviparum, Thalictum alpinum* and *Festuca rubra*. Higher up, at Hrólfshólar, H gives place to Ch. Here *Salix herbacea* is the most frequently occurring species. Everywhere throughout the moss carpet this plant sends up the tip of a branch bearing two or three leaves, while the rest of the plant is buried

in the moss. Other species met with are especially *Carex rigida, Polygonum viviparum, Silene acaulis, Armeria* and *Empetrum.* Proceeding still higher, *Salix herbacea* is the only more conspicuous phanerogam in the moss carpet.

At its lower limit the mosathembur vegetation passes over into the Elyna mo.

Above we have described the appearance and composition of the mosathembur vegetation on Lýngdalsheiði. If we enquire into its occurrence in other parts of Iceland, we find it described by Helgi Jónsson for East Iceland (1895, p. 70), for South Iceland (1905, pp. 40—42), and for Snæfellsnes (1900, p. 68 and p. 85). It is most abundantly developed in East Iceland where it covers large stretches of the mountain slopes in several of the fiords, and it is particularly well developed at high levels. In South and South-West Iceland it does not occur so plentifully, and apart from the lava fields, covers only small areas. Its appearance and composition, however, are in close agreement in the various localities and correspond to what was given above for Lýngdalsheiði.

In North Iceland and the highland tracts the mosathembur does not seem to occur as a stable typical vegetation. Ostenfeld does not refer to it in "Skildringer af Vegetationen i Island" III—IV (1905) either from Vestfirðir or from Melrakkasljetta. Personally I have looked for it in vain in Húna Flói, in the highlands at Arnarvatnsheiði, and on Holtavörðuheiði. Typical mosathembur was not seen in any of these localities; it had been replaced by the melar vegetation.

The moss mo observed by St. Stefánsson on Grimstungnaheiði which "should most probably be understood as a transitional form between heather mo and pond vegetation", the surface being uneven, more or less tufted, and the soil moist, at any rate in the first part of the summer, must not be confused with the mosathembur vegetation which only occurs on the relatively dry stretches. Thus, the mosathembur vegetation in Iceland seems to be peculiar to the higher levels of the rainy and foggy east, south, and south-west country, that is to say, the country south of the jökull line. North of this line, where the climate is more continental, it does not occur as the typical vegetation, being replaced by the melar vegetation here.

If we enquire into its distribution in the surrounding countries, we find it developed both to the north and to the south. Kolderup

Rosenvinge records a moss heath from South Greenland (1896, pp. 211—214) which, on p. 214, he refers to the Icelandic Grimmia heath. On the distribution of the moss heath the author writes on p. 213, "All the aforementioned localities are situated in the coastal area or not very far from the coast, whereas I have never observed such moss heaths in the interior." The most northerly moss heath is recorded from Marrak (63° 25′ N.). In East Greenland and farther north in West Greenland moss heath does not seem to occur.

Ostenfeld records Grimmia heath from the Faeroes (1906, pp. 116). Here it is peculiar to high mountain plateaus and is most abundantly developed in the northern islands. "It is a formation which seems peculiar to an insular and chilly climate" (p. 117).

From the higher regions of the Scottish mountains a Grimmia heath of identical appearance and composition is recorded in Tansley's Types of British Vegetation, 1911 p. 211.

In Scandinavia the Grimmia heath seems to have been replaced by the Lichen heath.

It holds good of the geographical distribution of the Grimmia heath as of its distribution in Iceland that it coincides with the position of the 20 % Ch biochore, and is peculiar to areas with abundant rainfall.

The Melar Vegetation. Cf. fig. 5 and table 10 A-B.

In the most exposed parts of the Grimmia patches the erosion of the wind in the rents of the moss carpet may often be observed. The single stems of the moss are loosened and carried away together with the layer of mould below. The erosion spreads both downwards and round about in the adjacent parts. Its downward action does not stop until the whole surface is paved with the scattered stones dispersed in the layer of mould. In the adjacent parts there is probably no limit to the activity of the erosion. When the mosathembur vegetation has been blown away, the wind works in the same way on the surrounding mo. Consequently large areas of the most exposed parts of Lýngdalsheiði are swept bare of vegetation, especially around Hrólfshólar and Thrasaborgir. These denuded areas, often termed "fell field" in phytogeographical literature, are called "melar" in Icelandic.

It is peculiar to melar in contrast to other types of vegetation that it is the colour and appearance of the soil rather than the vegetation that determine the physiognomy of the landscape. Ac-

cording to differences with regard to exposure, snow-covering, moisture of the soil, and age of the area, there seem to be differ-

Table 10 A. **The Melar Vegetation on Lýngdalsheiði.**

Localities 1–7 are situated round Hrólfshólar at about a height of 250 m above sea level. 1—2 examined on $^{12}/_{7}$ 1925, 3—6 on $^{22}/_{7}$, and 7 on $^{5}/_{7}$ 1925. (25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6	7
Polygonum viviparum ...	A 3	G	**76**	**84**	**68**	**60**	»	**80**	**68**
Agrostis canina	E 3	H	**60**	**68**	12	8	24	**60**	**88**
Salix herbacea	A 3	Ch	24	**60**	**64**	16	»	**88**	**64**
Festuca rubra...........	E 4	H	**52**	40	40	20	36	**84**	44
— ovina..........	E 4	H	24	**64**	**52**	**56**	20	32	44
Empetrum nigrum	E 4	Ch	»	**68**	8	»	»	**100**	**92**
Juncus trifidus..........	A 2	H	44	**56**	**56**	16	4	40	36
Thymus serpyllum	E 4	Ch	20	**56**	16	4	20	12	**76**
Luzula spicata	A 2	H	36	36	40	24	24	»	24
Loiseleuria procumbens..	A 2	Ch	»	28	»	»	»	**100**	**56**
Dryas octopetala	A 3	Ch	8	40	20	4	»	20	**56**
Cerastium alpinum	A 3	Ch	36	8	36	24	16	»	4
Armeria vulgaris	A 3	Ch	4	4	**52**	36	12	»	4
Silene acaulis	A 3	Ch	16	24	16	12	20	»	16
Arabis petræa	A 1	Ch	8	4	20	20	24	»	»
Cassiope hypnoides......	A 2	Ch	»	16	8	»	»	32	20
Alchemilla alpina	A 2	Ch	»	»	»	»	»	»	12
Bartschia alpina	A 2	H	»	»	4	»	»	4	4
Carex rigida	A 3	G	»	4	»	»	»	»	8
Deschampsia alpina	A 2	H	»	»	4	8	»	»	»
— flexuosa....	E 3	H	»	»	»	»	»	8	32
Elyna Bellardi	A 3	H	»	»	»	»	»	»	20
Equisetum variegatum...	A 3	H	»	»	»	»	»	»	4
Galium boreale	E 2	H	»	»	»	»	»	»	20
— Normanni	A 1	H	»	24	»	»	»	»	64
— verum	E 1	H	»	»	»	»	»	»	8
Luzula arcuata..........	A 3	H	»	»	24	8	»	»	»
Pingvicula vulgaris......	E 4	H	»	»	12	»	»	»	»
Poa glauca	A 3	H	4	»	16	»	4	»	»
Rumex acetosa..........	E 3	H	»	»	4	»	8	»	»
Salix glauca	A 3	Ch	»	»	8	»	»	»	4
Saxifraga hypnoides	A 1	Ch	»	»	»	»	8	»	»
Selaginella selaginoides ..	A 1	Ch	»	»	»	»	»	»	16
Silene maritima.........	A 1	Ch	»	»	»	4	»	»	»
Tofieldia palustris.......	A 2	H	»	»	»	»	»	»	12
Trisetum spicatum	A 3	H	»	4	»	»	»	»	20
Vaccinium uliginosum...	E 4	Ch	»	4	»	»	»	28	24

TABLE 10 B. **Biological Spectra of the Melar Vegetation.**

	1	2	3	4	5	6	7
Points sum	412	692	580	320	220	688	940
Number of species	14	20	22	15	13	14	29
Density of species	4.1	6.9	5.8	3·2	2.2	6.9	9.4
A	**62.1**	**56.6**	**75.2**	**72.5**	**50.9**	**52.9**	**54.5**
E	37.9	43.4	24.8	27.5	49.1	47.1	45.5
A 3	**40.8**	**32.9**	**52.4**	**50.0**	**23.6**	**27.3**	**28.5**
A 2	19.4	19.7	19.3	15.0	12.7	25.6	17.4
A 1	1.9	4.0	3.4	7.5	14.5	»	8.5
E 4	23.3	33.5	22.1	25.0	34.5	37.2	29.8
E 3	14.6	9.8	2 8	2.5	14.5	9.9	12.8
E 2	»	»	»	»	»	»	2.1
E 1	»	»	»	»	»	»	0.9
Ch	**28.2**	**45.1**	**42.8**	**37.5**	**45.5**	**55.2**	**47.3**
H	**53.4**	**42.2**	**45.5**	**43.8**	**54.5**	**33.1**	**44.6**
G	18.5	12.7	11.7	18.8	»	11.6	8.1
HH	»	»	»	»	»	»	»
Th	»	»	»	»	»	»	»

ences in the vegetation, but owing to the small part played by the vegetation in the appearance of the landscape it is difficult to form an idea as to how much this is the case. It is easiest to ascertain the connection between the vegetation and the age of the area as melar soil. On recently denuded patches hardly any plants are seen, whereas a good deal are seen to have immigrated at a somewhat later stage. Fig. 5 shows such a melar vegetation near Hrólfshólar, and table 10 A 1 and 4—5 give the circling results for this and similar localities on Lýngdalsheiði. The density of species is still rather low, 2—4, in spite of the comparatively high number of species, c. 15. Of life forms H and Ch are almost the sole prevailing ones. The most conspicuous species are *Thymus serpyllum*, *Salix herbacea*, *Armeria*, *Silene acaulis*, *Cerastium alpinum*, and *Arabis petraea*; of herbaceous plants *Juncus trifidus*, *Luzula spicata*, *Polygonum viviparum*, *Agrostis canina*, *Festuca ovina*, and *F. rubra* are met with.

On still older stretches of melar not only the vegetation but also the character of the soil have undergone change. The soil

owing to the fact that polygon-formation and solifluction are beginning to be prominent. The vegetation appears changed not only because species already present occur with greater frequency but also because new species have been added. The number of species has almost been doubled, the density has increased from c. 2—4 to c. 6—9. In table 10, 2—3 and 6—7 show the composition of the species on older, more stable tracts of melar. The increase falls especially to Ch. Of new species we may particularly mention *Dryas octopetala, Empetrum nigrum, Cassiope hypnoides, Loiseleuria procumbens, Luzula arcuata,* and a number of mo plants. *Dryas octopetala* only occurs in melar on Lýngdalsheiði, not, as is the case in the highlands and the north country, in mo. The presence of *Loiseleuria* and *Cassiope* would seem to show that the localities referred to not only differ from the abovementioned in age but also by being more snow-covered in winter.

On Lýngdalsheiði the melar vegetation is not very widespread, at any rate compared with the mo. In other parts of Iceland, however, it plays a prominent part in the physiognomy of the landscape, not only in the lowlands where it occurs in greatest quantity near the sea, but also and especially in the highlands where the country for miles is covered exclusively with the melar vegetation. At the higher levels it is almost the sole prevailing vegetation.

The melar vegetation or fell field is an arctic type of vegetation and has its greatest distribution north of Iceland, though it occurs at high levels in the Faeroes, Scotland and Scandinavia.

In spite of the great physiognomic differences between the melar and the mosathembur vegetation, the two types must be included in the same class, characterised with regard to environment by not being covered with snow in the winter and biologically by the comparatively great quantity of Ch and Å species, especially A 3 species. Both types have their main distribution in arctic regions about, above, or north of the 20 p. c. Ch biochore. The two types show a striking difference in regard to their biological spectra, the melar vegetation having a comparatively high H percentage and a low G percentage, the mosathembur vegetation a high G percentage.

The Mo Vegetation. Figs. 6—7, table 11 A—B.

The mo is the type of vegetation which occupies the largest area of Lýngdalsheiði as well as in the rest of the Icelandic lowlands. The term mo as used here includes all such formations as are normally covered with snow in the winter, whose degree of moisture is exclusively determined by the precipitation, not by the ground water, the soil of which is not in motion, uncultivated, and not covered with forest or copsewood. Thus defined, mo comprises the following of H. Jonsson's formations: heath, heather mo, grass mo, dwarf willow (in part), and grass-field (in part).

The soil of the mo is always more or less covered with knolls as shown in fig. 6. According to the inclination of the surface some differences appear which do not, however, seem to be of great importance in their bearing on the vegetation. Where the surface is level or slightly inclined, the knolls are almost polygonal, half a metre high and broad, and separated from each other by narrow furrows. Where the soil is more inclined, the knolls grow smaller and arrange themselves in longitudinal rows parallel to the edge of the slope. The form of the knoll undergoes a change, not only in that it becomes more elongated, but also because it begins to move downwards. This occurs by a displacement of the material of the knoll itself, apparent by its bulging in the middle of the more or less vertical side facing the valley, and becoming flattened on the upper side. Sometimes the upper side is bare, devoid of vegetation. If all the knolls become flat and bare on the upper side, and outwardly delimited by a vegetation curve, we get typical solifluction, which is especially well developed on melar in the highland tracts.

If the slope becomes still steeper, the solifluction will assume the character of a landslip. Then it is no longer the single knolls but the substratum that slips, and in consequence the vegetable covering may be preserved intact. Such landslips were observed in the highest stage of development in the highlands and the north country.

Since the mo forms the bulk of the vegetation as a feature of the landscape, it is obvious that forms transitional between the mo and the other types of vegetation must occur. In table 11, Nos. 1—5 represent the typical mo, No. 6 is a transitional form between mo and mosathembur, No. 7 a transitional form between mo and jaðar,

TABLE 11 A. **The Mo Vegetation on Lýngdalsheiði.**

Localities 1—7 situated in Lyngdalur c. 200 m above sea level. 8 between Hrólfshólar and Thrasaborgir c. 300 m above sea level (cf. table 13, 9). 9 on Thrasaborgir c. 400 m above sea level (cf. 13, 10). 1—5 and 8—9 represent the typical mo vegetation, 6 a form transitional between mo and mosathembur, 7 a moist mo. 1—6 examined on $^{2-8}/_{7}$ 1925, 7 on $^{29}/_{7}$ 1925, and 8—9 on $^{23}/_{7}$ 1925. (25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6	7	8	9
Salix herbacea	A 3	Ch	72	76	72	92	56	68	64	96	96
Empetrum nigrum	E 4	Ch	80	80	84	96	100	64	92	36	84
Polygonum viviparum	A 3	G	92	64	96	84	92	56	96	80	96
Festuca rubra	E 4	H	92	80	96	100	96	84	92	88	84
Agrostis canina	E 3	H	80	84	88	92	100	60	100	100	84
Deschampsia flexuosa	E 3	H	56	60	72	60	72	16	60	76	52
Carex rigida	A 3	G	92	84	88	100	64	84	96	84	80
Juncus trifidus	A 2	H	68	60	48	56	48	20	56	64	20
Luzula spicata	A 2	H	32	56	56	60	48	60	48	40	8
Galium boreale	E 2	H	72	60	80	76	76	4	80	92	56
— Normanni	A 1	H	72	68	80	88	76	56	76	84	32
Selaginella selaginoides	A 1	Ch	52	56	84	88	48	4	80	40	20
Equisetum pratense	E 2	G	40	56	96	36	24	40	28	»	»
— variegatum	A 3	H	36	16	12	8	4	16	12	8	48
Thalictrum alpinum	A 2	H	36	16	20	44	12	40	64	52	68
Silene acaulis	A 3	Ch	28	32	32	20	16	12	24	20	24
Thymus serpyllum	E 4	Ch	24	40	64	60	100	8	16	»	»
Cerastium alpinum	A 3	Ch	12	16	»	36	8	32	»	4	»
Trisetum spicatum	A 3	H	20	24	36	60	36	4	28	»	»
Festuca ovina	E 4	H	16	28	28	52	56	32	60	4	8
Agrostis tenuis	E 2	H	8	4	4	4	4	»	»	»	4
Cardamine pratensis	E 4	H	48	24	12	32	12	8	48	»	»
Vaccinium uliginosum	E 4	H	4	»	8	16	44	»	12	»	8
Elyna Bellardi	A 3	H	12	52	28	20	»	»	»	»	»
Anthoxanthumodoratum	E 3	H	12	24	»	4	32	»	8	»	»
Poa glauca	A 3	H	28	20	8	28	20	20	4	»	»
Pingvicula vulgaris	E 4	H	4	»	8	24	4	»	»	»	»
Galium verum	E 1	H	16	16	8	»	8	»	»	»	4
Arctostaphylos uva ursi	E 2	Ch	»	»	»	»	4	»	»	»	»
Armeria vulgaris	A 3	Ch	»	»	»	12	»	12	»	4	»
Botrychium Lunaria	E 4	G	»	8	4	»	»	»	»	»	»
Calluna vulgaris	E 2	Ch	4	4	»	»	»	»	»	»	»
Carex sparsiflora	A 1	G	4	4	»	»	»	»	12	»	»
Cerastium cæspitosum	E 3	Ch	»	»	»	»	»	»	»	4	»
Deschampsia caespitosa	E 2	H		»		4	»	4	28	»	
Equisetum arvense	E 4	G	»	»	»	20	»	40	12	»	12
— hiemale	E 3	H	»	»	»	»	8	»	»	»	»
Euphrasia latifolia	A 2	Th	»	»	4	8	8	4	»	»	4

TABLE 11 A CONTINUED.

			1	2	3	4	5	6	7	8	9
Geranium silvaticum...	E 3	H	»	»	»	4	4	»	»	»	»
Gnaphalium supinum ..	A 2	Ch	»	»	»	»	»	»	»	»	8
Habenaria hyperborea .	E 3	G	4	»	»	»	»	»	»	»	»
Loiseleuria procumbens	A 2	Ch	»	»	»	»	»	»	»	»	40
Luzula multiflora......	E 3	H	»	»	»	»	12	»	16	»	»
Poa alpina	A 2	H	»	»	4	»	»	»	»	»	
Potentilla verna	A 2	H	»	»	»	4	»	»	8	»	»
Ranunculus acer.......	E 4	H	4	»	»	8	4	»	»	4	»
Rumex acetosa	E 3	H	8	»	4	16	»	12	»	»	4
Salix glauca...........	A 3	Ch	»	4	»	4	4	»	»	»	»
— lanata...........	A 1	Ch	»	»	»	»	»	»	8	»	»
— phylicifolia	A 1	Ch	»	»	4	4	16	»	24	»	»
Taraxacum officinale...	E 2	H	4	»	»	»	»	»	12	»	»
Tofieldia palustris	A 2	H	»	»	»	4	»	»	»	»	»
Viola canina	E 3	H	»	16	12	»	»	»	»	»	
— palustris	E 3	H	8	»	»	»	8	»	20	»	»
Viscaria alpina	A 2	H	»	»	4	»	»	»	»	»	»

TABLE 11 B. **Biological Spectra of the Mo-Vegetation.**

	1	2	3	4	5	6	7	8	9
Points sum	1240	1232	1344	1524	1304	860	1384	980	944
Number of species ..	35	31	33	38	35	27	32	20	24
Density of species...	12.4	12.3	13.4	15.2	13.0	8.6	13.8	9.8	9.4
A	**52.9**	**52.5**	**50.3**	**53.8**	**41.1**	**56.7**	**50.6**	**58.7**	**57.6**
E	**47.1**	**47.4**	**49.7**	**46.2**	**58.9**	**43.3**	**49.4**	**41.2**	**42.4**
A 3.................	31.6	31.5	27.7	30.4	21.5	35.3	23.4	30.2	36.4
A 2.................	11.0	10.7	10.1	11.5	8.9	14.4	12.7	15.9	15.7
A 1.................	10.3	10.4	12.5	11.8	10.7	7.0	14.5	12.9	5.5
E 4.................	21.9	21.1	22.6	26.8	31.9	27.4	24.0	13.5	20.8
E 3.................	13.5	14.9	13.1	11.5	18.1	10.2	14.7	18.4	14.8
E 2.................	10.3	10.1	13.4	7.9	8.3	5.6	10.7	9.4	6.4
E 1.................	1.3	1.3	0.6	»	0.6	»	»	»	0.4
Ch	22.3	25.0	25.9	28.1	30.4	23.3	23.1	20.8	29.7
H	**59.0**	**57.5**	**52.7**	**55.6**	**55.2**	**50.7**	**59.2**	**62.4**	**50.0**
G	18.7	17.5	21.1	15.7	13.8	25.6	17.6	16.7	19.9
HH	»	»	»	»	»	»	»	»	»
Th	»	»	0.3	0.5	0.6	0.5	»	»	0.4

and finally, 8—9 are the mo vegetation at a somewhat higher level above the sea.

The mo vegetation is very rich in species, in 2.5 sq. m. there occur on an average 35 species of phanerogams or c. 10 p. c. of all Icelandic phanerogams. For the typical mo on Lýngdalsheiði the density of species is 12—15. The biological spectrum shows that H forms the bulk of the vegetation, constituting 50—60 p. c. of all the species noted. The Ch percentage is 25—30, the G percentage 15—2. Th occurs very sparingly. The proportion of the two species groups A and E is as 1 to 1.

As far as the floristic composition is concerned it is difficult to point out one or more species that are physiognomically dominant, and in that respect the knoll formation is most conspicuous.

Of chamaephytes *Salix herbacea* and *Empetrum nigrum* are most important, species such as *Thymus serpyllum*, *Silene acaulis*, and *Cerastium alpinum* being less conspicuous. The other *Salix* species, such as *S. glauca*, *S. lanata*, and *S. phylicifolia* are practically of no consequence, and the same is the case with *Vaccinium uliginosum* — this species occurs principally in mo which adjoins geiri, as shown in table 11, 5. *Calluna vulgaris* and *Arctostaphylos uva ursi* only occur in some few specimens in the mo round Lýngdalur; further down, at the foot of Lýngdalsheiði, both species were physiognomically predominant in the mo, whereas they were only found in the geiri in Lýngdalur. *Loiseleuria procumbens* only occurred sporadically; higher up, at Thrasaborgir, it was considerably more frequent. Of herbaceous plants *Polygonum viviparum*, *Galium boreale*, *G. Normanni* and *Thalictrum alpinum* are most important, a few other species occur more sporadically, particularly *Cardamine pratensis*.

It is, however, grasses or cyperaceous plants that dominate, such as *Festuca rubra*, *F. ovina*, *Agrostis canina*, *Carex rigida*, *Juncus trifidus*, *Elyna Bellardi*, *Luzula spicata*, further *Deschampsia flexuosa*, *Trisetum spicatum*, *Anthoxanthum odoratum*, and *Poa glauca*. Of vascular cryptogams *Selaginella selaginoides*, *Equisetum pratense*, and *E. variegatum* are most frequently met with, while *Botrychium Lunaria* and a few other *Equisetum* species occur now and again.

The typical mo on Lýngdalsheiði is thus characterised by a long series of species, each species occurring with a mean frequency characteristic of the species in question (mean F.-percentage) from which value the individual occurrences deviate but little. In table 11,

1—5 show what species are characteristic of the mo, and the F.-percentage of the individual species. Passing from the mo to one of the vegetation types previously mentioned, a transition zone will often be met with in which the frequencies of the species have undergone great changes. In table 11, 5, 6, and 7 show such transition zones passing into geiri, mosathembur, and jaðar respectively. A comparison of these zones, on the one hand with the mo vegetation, on the other with the respective types of vegetation, will show that statistically, biologically and floristically, the zones occupy this intermediate position.

No. 5 shows the transition from mo to geiri. The geiri plants *Vaccinium uliginosum, Luzula multiflora*, and *Anthoxanthum odoratum* show a comparatively high F.-percentage, while a mo plant *Elyna Bellardi* is inconspicuous. The proportion of A and E species points in the same direction. No. 6 is a transitional form between mosathembur and mo. A number of species which occur commonly in the mo, only appear sporadically here: this is the case with *Deschampsia flexuosa, Galium boreale, Selaginella selaginoides, Thymus serpyllum*, and *Trisetum spicatum*. The density of the species is appreciably diminished, being 8.6, and the character of the environment more arctic. The G percentage is comparatively high.

No. 7 is the moist mo which forms the transition to the jaðar vegetation. Most of the plants of the mo recur with the same F.-percentage, a number of jaðar plants such as *Deschampsia cæspitosa, Luzula multiflora, Salix phylicifolia, Viola palustris, Cardamine pratensis*, and *Taraxacum officinale* begin to thrive better.

Nos. 8—9 are typical mo at a somewhat higher level, viz. 300—400 m above sea level. The vegetation has assumed a more arctic character. *Salix herbacea* is beginning to predominate in the physiognomy of the vegetation.

As previously indicated, the mo is the most widely distributed type of vegetation in the Icelandic lowland where it probably comprises a fairly large number of formations. It must be left to future plant geographers to classify and characterise these formations with regard to environment, biology, and flora, and to correlate them.

The Jaðar Vegetation.

Between the mo, whose degree of moisture is exclusively determined by the precipitation, and the mýri, whose degree of moisture is determined, in addition, by the ground water, there occurs a belt

TABLE 12 A. **The Valllendi Vegetation on Lýngdalsheiði.**

All the localities examined were situated in the upper part of Lýngdalur at the foot of Hrólfshólar c. 200 m above sea level. 1—2 Salix-valllendi. 3—6 Deschampsia caespitosa-valllendi. 1—2 examined on $^{19}/_{7}$ 1925. 3—6 on $^{4-6}/_{7}$ 1925. (25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6
Salix lanata	A 1	Ch	**72**	36	»	»	»	»
— phylicifolia	A 1	Ch	**60**	**64**	»	»	»	»
Vaccinium uliginosum ...	E 4	Ch	44	12	»	»	»	»
Agrostis tenuis	E 2	H	4	**56**	**100**	**96**	**100**	**96**
Festuca rubra	E 4	H	**96**	**88**	**92**	**96**	**96**	**100**
Deschampsia caespitosa ..	E 2	H	**56**	28	**92**	**68**	**88**	**92**
— flexuosa	E 3	H	»	»	32	48	4	24
Carex rigida	A 3	G	20	24	**96**	**68**	**68**	40
Viola palustris	E 3	H	8	32	**92**	**68**	**96**	**76**
Galium boreale	E 2	H	44	**52**	**88**	**88**	**80**	**88**
Equisetum pratense	E 2	G	**52**	48	20	»	48	**56**
Agrostis canina	E 3	H	**84**	**76**	28	48	**56**	4
Polygonum viviparum ...	A 3	G	**64**	**68**	8	8	**56**	12
Galium verum	E 1	H	»	12	8	**52**	4	16
Alchemilla alpina	A 2	Ch	»	4	»	»	»	»
Cardamine pratensis	E 4	H	»	»	12	»	»	20
Empetrum nigrum	E 4	Ch	8	4	»	4	»	»
Equisetum arvense	E 4	G	»	»	»	»	20	4
— variegatum ..	A 3	H	»	»	4	8	»	»
Festuca ovina	E 4	H	4	40	»	4	»	8
Galium Normanni	A 1	H	»	12	»	4	»	4
Hierochloë odorata	E 2	G	»	»	4	»	8	4
Koenigia islandica	A 3	Th	28	»	»	»	»	»
Luzula spicata	A 2	H	4	»	»	»	»	»
Pingvicula vulgaris	E 4	H	4	»	»	»	8	»
Salix glauca	A 3	Ch	»	12	»	»	4	»
— herbacea	A 3	Ch	12	8	»	4	»	»
Selaginella selaginoides ..	A 1	Ch	»	»	»	4	»	4
Taraxacum officinale	E 2	H	8	4	4	»	»	4
Thymus serpyllum	E 4	Ch	»	4	»	»	»	»

which is moist in winter, spring, and autumn, but comparatively dry in the vegetation period. On this soil of a medium degree of moisture we meet with a vegetation which is in great part an intermediate form between the mo and the mýri vegetation but which, at the same time, comprises a number of specific species. It must be left to future investigators to decide whether there is sufficient

TABLE 12 B.

Biological Spectra of the Valllendi Vegetation.

	1	2	3	4	5	6
Points sum	672	684	680	668	736	652
Number of species	19	21	15	16	15	17
Density of species	6.7	6.8	6.8	6.7	7.4	6.5
A	38.7	33.3	15.9	14.4	17.4	9.2
E	**61.3**	**66.7**	**84.1**	**85.6**	**82.6**	**90.8**
A 3	18.5	16.4	15.9	13.2	17.4	8.0
A 2	0.6	0.6	»	»	»	»
A 1	19.6	16.4	»	1.2	»	1.2
E 4	23.2	21.6	15.3	15.6	16.8	20.2
E 3	13.7	15.8	22.4	24.6	21.2	16.0
E 2	**24.4**	**27.5**	**45.3**	**37.7**	**44.0**	**52.1**
E 1	»	1.8	1.2	7.8	0.5	2.5
Ch	29.2	21.1	»	1.8	0.5	0.6
H	**46.4**	**58.5**	**81.2**	**86.8**	**72.3**	**81.6**
G	20.2	20.5	18.8	11.4	27.2	17.8
HH	»	»	»	»	»	»
Th	4.2	»	»	»	»	»

difference between this type, the jaðar vegetation, on the one hand, and the mo and mýri vegetations on the other hand, to set it up as a type of the same standing as these. Much would seem to indicate that this is the case. Thus it is a factor of some importance that it appears as a very characteristic feature of the landscape in the highland tracts. *Deschampsia cæspitosa, Poa pratensis*, and *Agrostis tenuis* are characteristic species on jaðar soil. Types of Icelandic vegetation included herein are valllendi, tún, and mýri jaðar. The very remarkable flag vegetation is always associated with it, but owing to very divergent physiognomical, biological, and floristic peculiarities it must be set up as a special type of vegetation.

On Lýngdalsheiði the jaðar vegetation was represented by valllendi and mýri jaðar.

The Valllendi Vegetation. Cf. fig. 8 and table 12 A—B.

On the numerous small flat cones deposited by the streams of melting snow, occurring partly in Lýngdalur and partly scattered about throughout the heath, a characteristic vegetation, the valllendi

vegetation, was met with. It is possible to distinguish between two formations, a *Salix lanata* formation on the freshly formed soil, and a *Deschampsia cæspitosa* formation on somewhat older soil. In table 12, 1—6 show the composition of the vegetation in the two formations.

Nos. 1—2 represent the Salix lanata valllendi. The soil is only covered with vegetation in patches, the bed of the stream spreading like a net over the surface from the top of the cone, the meshes being filled in with the patches of vegetation. The vegetation is remarkable by the fact that chamaephytes are comparatively dominant physiognomically, especially the two Salix species, *Salix lanata* and *S. phylicifolia*; other Ch occur more sparingly, thus *Vaccinium uliginosum, Salix herbacea, S. glauca* and *Empetrum nigrum*. Of other plants grasses predominate, especially *Deschampsia cæspitosa, Agrostis canina*, and *Festuca rubra*, in less degree *Festuca ovina* and *Agrostis tenuis*. Of other species of more or less importance we may mention *Polygonum viviparum, Equisetum pratense, Galium boreale, Viola palustris,* and *Carex rigida.*

Nos. 3—6 represent the Deschampsia cæspitosa valllendi. This formation is always found where the two formations occur together, behind the Salix valllendi. The deposition of material has practically ceased here, no bare patches of sand are ever found, and the soil is covered by a dense vegetation of mosses.

The vegetation consists of a luxuriant carpet of hemicryptophytes, principally grasses. Physiognomically *Deschampsia cæspitosa* is the dominant species; in addition *Agrostis tenuis, Festuca rubra, Deschampsia flexuosa, Carex rigida,* and *Agrostis canina* are abundantly represented. Some herbaceous plants occur in the grassy carpet, thus *Galium boreale,* and *Viola palustris,* and less abundantly *Equisetum pratense, Polygonum viviparum,* and *Galium verum.*

The two formations occur with the same density of species, c. 7, and from a biological point of view they are remarkable by their large number of southern plants. An essential difference between them is the Ch content. Possibly this difference is due to cultural influences such as grazing or haying.

The Mýri Vegetation, the mýri jaðar and the flói vegetation. From considerations of space and owing to the close agreement between these types in Lýngdalur and at Björk, they will be treated later when the vegetation at Björk is dealt with.

The Geiri Vegetation. Figs. 9—10 and table 13 A—B.

Where for orographic reasons the snow forms a covering early in the autumn, remains on the ground in a more or less deep layer throughout the winter, and does not melt until late spring, a special type of vegetation is developed which may be called by the Icelandic name Geiri (the vegetation of the snow-patches).

It is a characteristic of the snow patch that the underlying soil is never knolly as is the case with the surrounding mo, and further that the vegetation is fairly luxuriant. These two circumstances in conjunction make the snow patch very conspicous even from a long way off (see figs. 9—10).

In table 13 A the circling results for the geiri vegetation of Lýngdalsheiði have been tabulated; this vegetation is only present in the middle and upper tracts of the heath, from c. 200 m above sea level and upwards. It was most characteristic at the upper levels.

The geiri vegetation comprises several formations which can be distinguished with regard to their environment by differences in the duration and depth of the snow-covering, the height above the sea, and illumination. As regards the general composition of the vegetation the following holds good. *Vaccinium uliginosum* is absolutely the dominant plant, in conjunction with *Empetrum nigrum* and *Deschampsia flexuosa* it forms the bulk of the dense luxuriant carpet of vegetation. Species like *Salix herbacea, Calluna vulgaris, Agrostis canina, Festuca rubra, Anthoxanthum odoratum, Luzula multiflora, Carex rigida, Galium boreale, G. Normanni, Cardamine pratensis*, and *Taraxacum officinale* also abound. *Rubus saxatilis, Geranium silvaticum*, and *Vaccinium myrtillus* are characteristic of the geiri on Lýngdalsheiði. None of these species has been met with in any other type of vegetation. Some typical mo plants occur dispersed throughout the vegetation, in greatest quantity in the least typical snow patches, or in the margin of the larger ones.

In small depressions in the mo, where the snow-covering gives rise to another vegetation than in the mo itself, this vegetation is fairly uniform throughout the depression. In deeper depressions a difference between the vegetation at the bottom and up the sides may be perceived. In table 13 A, 4—5 show respectively the typical geiri vegetation and the vegetation on the sunny northern side of the snow patch. Here the density of species is somewhat greater, 15.5 as against 13.6, owing to a contingent of mo plants.

In still deeper snow patches one may distinguish between a

TABLE 13 A. **The Geiri Vegetation on Lýngdalsheiði.**

Localities 1–8 situated in Lyngdalur c. 200 m above sea level. 9 between Hrólfshólar and Thrasaborgir c. 300 m above sea level (cf. table 11, 8). 10 on Thrasaborgir c. 400 m above sea level (cf. table 11, 9). 1 examined on $^2/_7$ 1925, 2 on $^5/_7$, 3 on $^8/_7$, 4—8 on $^{10}/_7$, 9—10 on $^{23}/_7$ 1925. 1—4, 9—10: 25. $^1/_{10}$ m^2, 5—8: 10 $^1/_{10}$ m^2).

			1	2	3	4	5	6	7	8	9	10
Vaccinium uliginosum	E 4	Ch	100	100	100	96	100	100	»	»	88	28
Empetrum nigrum	E 4	Ch	100	100	100	80	100	100	90	»	80	64
Deschampsia flexuosa	E 3	H	100	100	96	96	100	100	70	100	100	96
Galium boreale	E 2	H	100	92	84	72	90	70	40	70	68	84
Salix herbacea	A 3	Ch	68	16	16	76	30	20	80	»	96	96
Calluna vulgaris	E 2	Ch	40	52	64	28	100	70	100	»	»	»
Agrostis canina	E 3	H	68	100	76	44	60	80	90	70	100	76
— tenuis	E 2	H	8	»	72	80	30	80	»	100	8	52
Polygonum viviparum	A 3	G	48	8	»	52	60	»	80	»	40	68
Festuca rubra	E 4	H	56	52	80	80	70	70	70	70	68	80
Anthoxanthum odoratum	E 3	H	4	52	28	72	100	40	10	»	12	24
Luzula multiflora	E 3	H	»	20	»	20	40	10	20	»	4	»
Carex rigida	A 3	G	40	68	64	60	60	30	»	70	84	64
Galium Normanni	A 1	H	32	32	8	36	70	»	40	»	»	8
— verum	E 1	H	4	16	»	12	50	10	20	»	»	4
Selaginella selaginoides	A 1	Ch	12	8	8	24	20	»	30	»	12	36
Equisetum pratense	E 2	G	16	16	4	12	40	10	20	10	24	8
Taraxacum officinale	E 2	H	4	32	12	68	»	20	»	»	12	8
Geranium silvaticum	E 3	H	»	4	4	24	70	»	»	»	12	»
Vaccinium Myrtillus	E 2	Ch	»	»	»	88	60	30	»	»	12	88
Deschampsia cæspitosa	E 2	H	»	»	»	12	»	»	»	80	4	»
Viola palustris	E 3	H	»	»	28	76	»	20	»	100	44	52
Cardamine pratensis	E 4	H	36	12	4	32	60	»	»	»	»	»
Rubus saxatilis	E 3	H	12	4	4	12	»	»	»	»	»	»
Gnaphalium supinum	A 2	Ch	»	»	»	»	»	»	»	»	12	88
Sibbaldia procumbens	A 2	Ch	»	»	»	»	»	»	»	»	12	44
Alchemilla alpina	A 2	Ch	»	»	»	»	»	»	»	»	12	16
— minor	E 4	H	»	»	»	24	»	»	»	»	4	12
Hierochloë odorata	E 2	G	»	8	»	»	»	»	»	»	16	40
Armeria vulgaris	A 3	Ch	»	»	»	4	»	»	»	»	»	»
Bartschia alpina	A 2	H	»	»	»	»	»	»	10	»	»	»
Betula nana	A 2	Ch	»	4	»	»	»	»	»	»	»	»
Carex sparsiflora	A 1	G	8	8	»	»	»	»	»	»	»	»
Cassiope hypnoides	A 2	Ch	»	»	»	»	»	»	»	»	»	4
Elyna Bellardi	A 3	H	»	»	»	»	10	»	10	»	»	»
Equisetum arvense	E 4	G	»	»	»	4	»	»	»	»	»	4
— hiemale	E 3	H	»	»	4	12	»	»	»	»	4	4
Eriophorum polystachyum	E 4	G	»	»	»	4	»	»	»	»	»	»

TABLE 13A CONTINUED.

			1	2	3	4	5	6	7	8	9	10
Euphrasia latifolia	A 2	Th	»	»	»	»	»	»	»	»	»	4
Festuca ovina	E 4	H	»	4	»	»	»	»	20	»	»	4
Gnaphalium norvegicum .	A 1	H	»	»	»	»	»	»	»			4
Hieracium silvaticum....	E 2	H	»	»	»	»	10	»	»			
Juncus trifidus..........	A 2	H	8	»	»	»	40	»	20	»	»	»
Leontodon autumnale ...	E 3	H	»	»	»	24	»	»	»	»	4	4
Luzula spicata	A 2	H	8	»	»	»	»	»	10	»		
Lycopodium alpinum....	A 2	H	»	»	»	»	»	»	»	»	8	
Nardus stricta	E 3	H	»	»	»	8	»	»	»	»		
Orchis maculata	E 2	G	»	»	»	8	40	»	10	»		
Pirola minor.............	E 4	H	»	»	»	4	»	»	»	»	»	»
Ranunculus acer	E 4	H	»	»	»	»	»	»	»	»	»	4
Salix glauca.............	A 3	Ch	»	»	»	»	10	»	»	»	»	4
— lanata............	A 1	Ch	4	»	8	»	»	»	»	»	»	
— phylicifolia	A 1	Ch	»	4	4	4	»	»	»	»	»	4
Thalictrum alpinum.....	A 2	H	12	8	»	12	»	»	»	»	12	12
Thymus serpyllum	E 4	Ch	4	8	»	»	80	»	20	»	»	»
Tofieldia palustris.......	A 2	H	»	»	»	»	»	»	10	»	»	»
Trisetum spicatum	A 3	H	»	»	»	»	10	»	»	»	»	»
Viola canina............	E 3	H	»	»	»	»	40	»	»	»	»	»

sunny northern margin, No. 7, the typical geiri vegetation chiefly occurring along the sides of the snow patch, No. 6, and the vegetation at the bottom of the snow patch, No. 8. The northern margin is more arctic in character than the typical vegetation. The A percentage is 39.6, while it is only 5.8 for the typical vegetation. The bottom vegetation is almost identical with the previously described *Deschampsia cæspitosa* valllendi both biologically and floristically.

The vegetation of the snow patches at higher levels of Lýngdalsheiði, thus at a height of c. 300—400 m, is shown in table 13 A, 9—10. In its broad features it corresponds to the geiri vegetation at lower levels, though a number of species of common occurrence in the snow patches of Lyngdalur have disappeared, thus *Calluna vulgaris*, *Luzula multiflora*, and several *Galium* species. Others again have become less conspicuous, but on the other hand some new species have been added such as *Gnaphalium supinum*, *G. norvegicum*, *Sibbaldia procumbens*, *Alchemilla alpina*, *A. minor*, *Hierochloë odorata*, and *Veronica alpina*. These species seem to be characteristic of the snow patches in the upper parts of Lýngdalsheiði.

TABLE 13 B. **Biological Spectra of the Geiri-Vegetation.**

	1	2	3	4	5	6	7	8	9	10
Points sum	892	928	868	1360	1550	860	960	670	960	1104
Number of species	24	27	22	35	27	17	23	9	28	33
Density of species	8.9	9.3	8.7	13.6	15.5	8.6	9.6	6.7	9.6	11.0
A	26.9	16.8	12.4	19.7	20.0	5.8	39.6	10.4	30.0	40.9
E	**73.1**	**83.2**	**87.6**	**80.3**	**80.0**	**94.2**	**60.4**	**89.6**	**70.0**	**59.1**
A 3	17.5	9.9	9.2	14.1	11.6	5.8	17.7	10.4	22.9	21.0
A 2	3.1	1.3	»	0 9	2.6	»	14.6	»	5.8	15.2
A 1	6 3	5.6	3.2	4.7	5.8	»	7.3	»	1.3	4.7
E 4	33.2	29.7	32.7	23.8	26.5	31.4	20.8	10.4	25.0	17 8
E 3	20.6	30.2	27.6	28.5	26.5	29.1	19.8	40.3	30.0	23.6
E 2	**18.8**	**21.6**	**27.2**	**27.1**	**23.9**	**32.6**	**17.7**	**38.8**	**15.0**	**17.4**
E 1	0.4	1.7	»	0.9	3.2	1.2	2.1	»	»	0.4
Ch	36.8	31.5	34.6	29.4	32.3	37 2	42.7	»	33.8	34.8
H	**50.7**	**56.9**	**57.6**	**60.3**	**54.8**	**58.1**	**45.8**	**88.1**	**49.2**	**48.2**
G	12.6	11.6	7.8	10.3	12.9	4.7	11.5	11.9	17.1	16.7
HH	»	»	»	»	»	»	»	»	»	»
Th	»	»	»	»	»	»	»	»	»	0.4

In arctic, Scandinavian, Scottish, and alpine regions these plants are likewise, according to the records, peculiar to places with a deep and persistent snow-covering. The two *Alchemilla* spp. seem to prefer the upper parts of the snow patch, whereas they are absent from the lower parts. — The two snow patch localities correspond to two mo localities, viz. 8—9 in table 11.

Biologically the geiri vegetation is characterised by its low A percentage and high E percentage. The increase in the E percentage is especially due to E 3 and E 2.

B. THE VEGETATION AT BJÖRK.

Above we have described the vegetation in the middle and upper tracts of Lýngdalsheiði, in the following we will subject the vegetation at its foot to further discussion. All investigations of the vegetation were carried out in the vicinity of the Björk farm and with this as their base. It is situated at the foot of Lýngdalsheiði's eastern side at an altitude of c. 100 m.

Some of the types of vegetation recorded from Lýngdalur recur here, viz. mo, jaðar, mýri, and flói, while melar, mosathembur, and geiri were not developed. In addition there occurred the flag vegetation.

The Mo Vegetation. Cf. table 14 A—B.

In its broad features the appearance and floristic composition of the mo around Björk corresponds to the above-described mo at the higher levels of Lýngdalsheiði.

The soil has the same knolly surface as that previously decribed, but the knolls are less conspicuous on the slopes than on the flatter parts. The composition of the vegetation is likewise very similar. Almost all the species found in the mo in Lýngdalur recur here and in approximately the same proportions. There are, however, also typical differences partly between this mo and that at the higher levels, and partly between the various parts of the mo around Björk.

Three mo formations could be distinguished, an Elyna mo, an Arctostaphylos mo, and a Calluna-Empetrum mo. These three formations differ in the following way. The Elyna mo is found on the top of the many little mounds and hills which are covered at the higher levels of Lýngdalsheiði by the mosathembur vegetation, and have a comparatively thin snow-covering. The Arctostaphylos mo is found on the sunny slopes of these hills below the Elyna mo, and in the drier depressions among them. The snow-covering is somewhat deeper here and more persistent than in the Elyna mo; it is the normal snow-covering in these parts. Transitional between the Arctostaphylos mo and the jaðar is the third mo formation, the Calluna-Empetrum mo. Like the Arctostaphylos mo, this formation has the normal snow-covering in winter, but differs from the Arctostaphylos mo by being more damp. Here the ground water has an appreciable influence on the vegetation. In table 14 A the circling results for these three mo formations have been tabulated.

Plants common to the three mo formations and the mo at higher levels and characteristic of the mo are, e. g. *Empetrum nigrum, Thymus serpyllum, Salix herbacea, Festuca rubra, F. ovina, Agrostis canina, Carex rigida, Juncus trifidus, Luzula spicata, Polygonum viviparum, Thalictrum alpinum, Selaginella selaginoides*, and *Equisetum variegatum.* Table 14 A shows the proportion in which the various species occur and the good agreement between the

TABLE 14 A. **The Mo Vegetation at Björk.**

Localities 1—10 are all situated round Björk c. 100 m above sea level. 1—4 the Elyna mo, 5—7 the Arctostaphylos mo, 8—10 the Calluna-Empetrum mo (the moist mo). 1, 3 and 5 examined on $^{16}/_{7}$ 1925, 2, 6, 7 and 8 on $^{17}/_{7}$, 9 on $^{21}/_{7}$, and 4 and 10 on $^{24}/_{7}$ 1925.
(25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6	7	8	9	10
Arctostaphylos uva ursi..	E 2	Ch	»	»	4	»	**88**	**96**	**96**	4	4	[illegible]
Calluna vulgaris	E 2	Ch	»	12	4	»	**76**	**80**	**100**	**96**	**80**	**80**
Empetrum nigrum	E 4	Ch	**100**	**92**	**88**	**80**	**100**	**100**	**100**	**100**	**100**	**100**
Thymus serpyllum	E 4	Ch	**96**	**92**	**76**	**56**	**88**	**92**	**72**	**64**	**80**	**64**
Vaccinium uliginosum ...	E 4	Ch	8	12	12	»	**88**	**80**	**72**	**68**	36	44
Salix herbacea	A 3	Ch	**72**	**60**	**68**	4	**80**	**68**	32	28	20	20
Festuca rubra	E 4	H	**96**	**96**	**100**	**96**	**92**	**100**	**92**	**100**	**100**	**96**
— ovina...........	E 4	H	**76**	40	8	28	**84**	**80**	**68**	**76**	**60**	**84**
Deschampsia flexuosa....	E 3	H	8	8	40	16	**68**	**52**	40	**56**	36	20
Agrostis canina	E 3	H	**88**	**96**	**96**	**100**	**96**	**100**	**92**	**84**	**100**	**88**
Carex rigida	A 3	G	**76**	**92**	**92**	**80**	**64**	**88**	**60**	**68**	**88**	**76**
Polygonum viviparum ...	A 3	G	**84**	**72**	**56**	48	**68**	**80**	**80**	**100**	**92**	**84**
Thalictrum alpinum.....	A 2	H	32	24	**64**	36	16	48	**64**	**68**	**68**	**60**
Galium Normanni.......	A 1	H	**88**	**88**	**96**	**80**	**72**	56	32	48	44	**68**
— boreale	E 2	H	4	48	12	40	**84**	52	44	28	**68**	48
Juncus trifidus..........	A 2	H	48	48	36	48	44	36	40	32	**76**	36
Elyna Bellardi	A 3	H	36	**68**	48	**60**	16	4	16	44	**64**	28
Luzula spicata	A 2	H	**64**	20	32	32	24	36	**52**	16	12	28
Selaginella selaginoides ..	A 1	Ch	**52**	36	32	40	20	28	4	**52**	48	28
Equisetum pratense	E 2	G	36	16	16	4	20	44	40	**60**	**88**	32
— variegatum ..	A 3	H	»	24	24	32	4	32	16	8	12	36
Silene acaulis	A 3	Ch	32	12	16	20	4	12	4	4	8	16
Trisetum spicatum	A 3	H	8	20	8	**52**	»	20	»	8	24	»
Anthoxanthum odoratum.	E 3	H	»	»	40	4	20	12	4	12	»	»
Luzula multiflora	E 3	H	4	»	16	»	16	4	24	8	8	12
Cardamine pratensis	E 4	H	4	»	12	36	»	»	24	**84**	**52**	**56**
Salix lanata.............	A 1	Ch	»	4	»	4	12	»	4	28	16	28
— phylicifolia........	A 1	Ch	»	»	»	»	»	»	»	28	4	8
Carex sparsiflora........	A 1	G	»	»	»	»	8	12	»	40	8	12
Deschampsia caespitosa..	E 2	H	»	»	»	»	»	»	»	12	24	20
Taraxacum officinale	E 2	H	»	»	4	»	4	»	4	20	4	20
Agrostis tenuis..........	E 2	H	»	»	»	»	4	»	»	20	8	28
Equisetum arvense......	E 4	G	»	»	»	40	»	»	»	4	12	32
Rumex acetosa..........	E 3	H	»	»	»	»	»	»	»	8	4	8
Viola palustris..........	E 3	H	»	»	»	»	»	»	»	8	8	4
Alchemilla alpina	A 2	Ch	»	»	4	»	»	»	»	»	»	»
Armeria vulgaris........	A 3	Ch	»	4	»	»	»	»	»	»	»	4
Bartschia alpina	A 2	H	»	»	»	»	»	»	4	»	»	[illegible]

TABLE 14 A CONTINUED.

			1	2	3	4	5	6	7	8	9	10
Botrychium Lunaria	E 4	G	8	»	8	4	»	»	»	4	8	»
Carex rariflora	A 2	G	»	»	»	»	»	»	»	»	4	»
Cerastium alpinum	A 3	Ch	24	»	»	28	»	»	»	4	8	8
Equisetum hiemale......	E 3	H	»	»	»	4	»	»	»	»	»	»
Erigeron neglectus	A 1	H	»	»	»	»	»	»	4	»		»
Euphrasia latifolia	A 2	Th	»	»	»	»	»	»	»	4	»	»
Galium verum	E 1	H	»	12	32	36	»	»	12	20	4	»
Habenaria viridis	A 1	G	»	»	4	»	»	»	»	»	»	»
Hieracium silvaticum....	E 2	H	»	»	»	»	»	»	4	4	»	»
Leontodon autumnale ...	E 3	H	»	»	»	»	»	»	»	»	4	»
Pingvicula vulgaris	E 4	H	»	»	»	»	»	4	4	8	8	»
Poa glauca	A 3	H	»	»	20	8	»	»	»	»	»	4
Potentilla verna.........	A 2	H	4	»	»	4	»	»	»	»	4	16
Ranunculus acer	E 4	H	»	»	»	»	»	»	»	4	»	»
Rhinanthus minor	E 2	Th	»	»	»	»	»	8	»	»	»	»
Salix glauca	A 3	Ch	»	»	»	4	»	»	»	»	»	»
Viola canina	E 3	H	»	»	»	»	8	»	»	»	12	»

TABLE 14 B. **Biological Spectra of the Mo-Vegetation.**

	1	2	3	4	5	6	7	8	9	10
Points sum	1148	1096	1168	1124	1368	1424	1304	1532	1508	1396
Number of species.	25	25	32	31	29	28	32	41	42	36
Density of species.	11.5	11.0	11.7	11.2	13.7	14.2	13.0	15.3	15.1	14.0
A	**54.0**	**52.2**	**51.4**	**51.6**	31.6	36.5	31.6	37.9	39.8	40.1
E	46.0	47.8	48.6	48.4	**68.4**	**63.5**	**68.4**	**62.1**	**60.2**	**59.9**
A 3...............	28.9	32.1	28.4	29.9	17.3	21.3	16.0	17.2	21.0	19.8
A 2...............	12.9	8.4	11.6	10.7	6.1	8.4	12.3	7.8	10.9	10.0
A 1...............	12.2	11.7	11.3	11.0	8.2	6.7	3.4	12.8	8.0	10.3
E 4...............	33.8	30.3	26.0	30.2	33.0	32.0	33.1	33.4	30.2	34.1
E 3...............	8.7	9.5	16.4	11.0	15.2	11.8	12.3	11.5	11.4	9.5
E 2...............	3.5	6.9	3.4	3.9	20.2	19.7	22.1	15.9	18.3	16.3
E 1...............	»	1.1	2.7	3.2	»	»	0.9	1.3	0.3	»
Ch	33.4	29.6	26.0	21.0	40.6	39.0	37.1	31.1	26.8	28.7
H	**48.8**	**54.0**	**58.9**	**63.3**	**47.7**	**44.7**	**49.1**	**50.7**	**53.3**	**54.4**
G	17.8	16.4	15.1	15.7	11.7	15.7	13.8	18.0	19.9	16.9
HH	»	»	»	»	»	»	»	»	»	»
Th	»	»	»	»	»	0.6	»	0.3	»	»

species in the three formations; if compared with table 11, it will further show the agreement between the mo at Björk and that of Lýngdalur.

The Elyna Mo. Table 14 A, 1—4. The dominant here is *Elyna Bellardi.* It occurs especially at the top of the knolls and with its brown, tufted stems it contributes markedly to the peculiar physiognomy of the vegetation. Other characteristic plants are *Silene acaulis, Cerastium alpinum, Trisetum spicatum,* and *Poa glauca.* These species attain their finest development here even though they are also found in the other formations. Further it is characteristic of the Elyna mo that a number of species otherwise always present in the mo are rare or absent here, viz. *Vaccinim uliginosum, Calluna vulgaris, Arctostaphylos uva ursi, Deschampsia flexuosa, Galium boreale,* and *Luzula multiflora.* All these plants are southern species.

The Arctostaphylos mo. Table 14 A, 5—7. Physiognomically characteristic of this formation are above all *Arctostaphylos uva ursi, Calluna vulgaris,* and *Vaccinium uliginosum;* further there occur *Deschampsia flexuosa, Galium boreale, Luzu lamultiflora,* and *Anthoxanthum odoratum.* On the other hand, *Elyna Bellardi, Selaginella selaginoides, Silene acaulis, Cerastium alpinum, Trisetum spicatum,* and *Poa glauca* are not dominant, a feature by which this formation differs from the Elyna mo. The difference between the two mo formations thus consists in the fact that the Elyna mo has many arctic but comparatively few southern species in contrast to the Arctostaphylos mo in which the southern species are dominant. This difference is decidedly due to the difference in the snow-covering. From both formations the species requiring moisture, which occur in the Empetrum mo, are absent.

The Calluna-Empetrum Mo. As mentioned above, this formation occurs as a narrow border between the Arctostaphylos mo and the jaðar, and it is particularly well developed where the ground is slightly inclined. The most striking difference between this and the above-mentioned formation is the absence of *Arctostaphylos uva ursi.* Owing to the immediate vicinity of the jaðar some of the plants characteristic of that formation are met with, though sporadically, thus *Carex sparsiflora, Cardamine pratensis, Deschampsia cæspitosa, Taraxacum officinale, Agrostis tenuis, Equisetum arvense, Viola palustris, Salix lanata,* and *S. phylicifolia.*

The situation of these two formations in relation to each other affords an excellent illustration of the relation to moisture of *Arctostaphylos uva ursi* and *Calluna vulgaris*. On the heath of Jutland we may similarly distinguish between a higher tract with *Arcstostaphylos* and *Calluna* and a lower tract where *Arctostaphylos* is absent. Though the environment differs widely in the Icelandic mo and the heath of Jutland, it is worth noting that species which they have in common react similarly to the same change of environment. It is not the sum of environmental factors but the individual factors of the environment which determine the distribution of the species.

The Jaðar and Mýri Vegetations. Fig. 11 and table 15 A—B.

In areas where the degree of moisture is determined both by the precipitation and the ground water we meet with those stretches which are called "mýrar" in Icelandic. Owing to the abundant precipitation the mýri is very extensively distributed throughout the Icelandic lowlands. Several types of mýri are found. Of most common occurrence is the »fórmýri« or swampy mýri, formed in cup-shaped depressions on level or slightly inclined ground. Its formation and peculiarities are due to the sour stagnant ground water. Where the soil grows very damp, that is to say, where the ground water covers the bottom all the year round, swampy stretches, "floar" are formed. The second type of mýri is the »hallamýri" or well mýri. This is formed where the ground water is pressed up out of the soil, hence it is often seen at the foot of mountains. Where the water is pressed up with such force that springs are formed and where the bottom is therefore swampy and damp all the year round the "dý" vegetation is formed.

The third type of mýri is the "fétmýri" or irrorated mýri formed on tracts inundated by water for shorter or longer periods of the year. Natural fétmýrar are thus formed on the banks of rivers but most extensively in deltas near the sea. The characteristic plant in this type of mýri is *Carex Lyngbyei*, and since this plant is an important forage plant, successful damming experiments have lately been made with a view to creating conditions for an inundation mýri in places where it was not formerly found.

Three different types of vegetation are associated with these three types of mýri. I was afforded most opportunity for a thoroughgoing study of the swampy mýri which I investigated both in Lyng-

dalur, at Björk, and at Lækjamót in the north country. The ridge mýri I have only investigated at Lækjamót, while I had no opportunity of a close study of the fétmýri.

The composition of the swampý mýri in Lyngdalur and at Björk is shown in table 15 A, 1—11.

Fig. 11 shows the appearance of the mýri at Björk. The soil is markedly knolly, but the knolls are smaller and more scattered than on the mo.

According to the degree of moisture of the soil it is possible to distinguish between the following formations. The mýri jaðar (the margin of the mýri) or the grass mýri is first met with on passing from the mo on to the mýri. Upwards it passes into the moist mo, the *Calluna-Empetrum* mo. The ground water hardly ever comes up to the surface, but the bottom is damp in spring, winter, and autumn, whereas, in the vegetation period, it is comparatively dry. Outwards the jaðar passes into the dry cyperaceous mýri, the Salix mýri. The soil is here considerably more moist, in wet summers the water will perhaps cover the surface throughout the vegetation period; normally, however, this vegetation will not be covered with surface water the greater part of the vegetation period, in dry summers perhaps not at all. On the dampest soil we find the moist cyperaceous mýri or the Betula nana mýri. The bottom must here be assumed to be covered with water even in normal summers; in very dry summers dry bottom may no doubt be found in this formation, too. The flói, or swamp, is met with in spots in this formation. Here the bottom is always covered with water, even in dry summers. The knolls, so typical of the mýri, are not present in the flói, and while the soil of the mýri is firm to the tread, rendered solid by a dense web of Cyperaceae rhizomes, the ground in the flói is soft and muddy, and one moves on it in constant fear of sinking into the slush.

On a gentle slope these 4 belts will succeed each other in the sequence described above, adjoining the moist mo upwards, while outwards they will perhaps be succeeded by a collection of water, a "tjörn" (tarn). Where the surface is more irregular, a comparatively moist formation will not rarely adjoin a comparatively dry one, while the intermediate formations are not developed.

The Jaðar Vegetation. Table 15 A, 1—3 shows the floristic composition of this vegetation in Lýngdalur and at Björk. The

number of species and density are comparatively high, on an average c. 40 species in 25 sq. m. with a density of c. 14. The southern species play a much greater part than the arctic species; of the life forms H predominate with an average percentage amount of more than 50. Ch attain their minimum here; both above and below they constitute a larger percentage amount of the vegetation than here. The G percentage is somewhat higher than in the mo.

With regard to the floristic composition, we find not only a number of species from the mo, such as *Empetrum nigrum*, *Vaccinium uliginosum*, *Salix herbacea*, *Polygonum viviparum*, *Thalictrum alpinum*, *Agrostis canina*, *Festuca rubra*, *F. ovina*, and *Carex rigida*, but also a number of species which must be said to be peculiar to the jaðar. Of these *Deschampsia cæspitosa*, the typical dominant for the jaðar, must especially be noted, even though its F.-percentage is not always very high. Further *Agrostis tenuis*, *Carex sparsiflora*, *C. capitata*, *Taraxacum officinale*, *Cardamine pratensis*, and *Viola palustris*, as also the *Salix* species, *S. phylicifolia* and *S. lanata*. Most of these species attain their maximum development here. Of plants peculiar to the mýri *Carex Goodenoughii* is the only one which plays any great part in the jaðar vegetation.

The Salix Mýri. Table 15 A—B, 4—6.

Similarly to the jaðar this formation has a large average number of species and high average density, though not as high as in the jaðar. While grasses were dominant in the jaðar here it is the Cyperaceae, and the result is a great decrease in the H percentage and a corresponding increase of the G percentage in the biological spectrum. HH are gradually gaining ground and are represented by c. 6—8 p. c. in the spectrum. The Ch percentage is somewhat higher than in the jaðar. The proportion of A and E species is practically the same for this and the above-mentioned formation, but there is a displacement within the subgroups. The E 2 percentage is comparatively high in the former, considerably lower in the latter formation.

Floristically the Salix mýri differs from the jaðar in that the grasses play a very slight part, while the *Salix* species are the same. From the Betula nana mýri it is distinct by the absence of the characteristic species of that formation, *Betula nana*, but it has the same cyperaceous flora. The dominant species are *Carex Goodenoughii*, *Eriophorum polystachyum* and the *Salix* spp. especially

TABLE 15 A.

The Jaðar and Mýri Vegetation on Lýngdalsheiði and at Björk.

Localities 1—3 represent the Jaðar vegetation. No. 1 in Lyngdalur c. 200 m above sea level. 2—3 at Björk c. 100 m above sea level. 4—6 the Salix mýri, 4—5 at Björk, 6 in Lyngdalur. 7—11 the Betula nana mýri, 7—9 in Lyngdalur, 10—11 at Björk. 9 examined on $^{4}/_{7}$ 1925, 2 and 11 on $^{18}/_{7}$, 5 on $^{20}/_{7}$, 4 on $^{21}/_{7}$, 1, 6, 7 and 8 on $^{22}/_{7}$, and 10 on $^{25}/_{7}$ 1925. (25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6	7	8	9	10	11
Deschampsia caespitosa.	E 2	H	**64**	44	**72**	12	»	4	»	»	»	»	»
Calamagrostis neglecta .	E 4	H	**56**	8	44	»	»	»	8	»	»	»	»
Agrostis tenuis	E 2	H	**96**	44	4	4	4	»	»	»	»		
Carex rigida...........	A 3	G	**100**	28	**56**	4	8	**60**	»	**52**	48	»	»
Cardamine pratensis ...	E 4	H	48	**60**	**80**	**60**	20	24	4	»	8	16	8
Agrostis canina	E 3	H	**72**	32	48	32	32	28	»	4	»	»	»
Viola palustris	E 3	H	36	**68**	28	**88**	**64**	44	»	»	»	»	12
Festuca rubra	E 4	H	**96**	**96**	**100**	**88**	**80**	**92**	12	32	32	4	24
— ovina	E 4	H	**72**	**80**	**68**	**96**	48	44	»	12	»	»	20
Salix phylicifolia	A 1	Ch	**88**	32	8	20	32	**72**	40	12	16	24	24
— lanata	A 1	Ch	»	**52**	**52**	**76**	**60**	8	»	»	»	»	4
— herbacea	A 3	Ch	20	**60**	12	28	**56**	48	16	24	4	»	16
Equisetum arvense	E 4	G	48	**60**	20	20	**56**	16	»	»	»	»	»
Polygonum viviparum..	A 3	G	**96**	**92**	**92**	**96**	**92**	**92**	**92**	**92**	**96**	**88**	**72**
Thalictrum alpinum ...	A 2	H	**96**	**80**	**80**	40	**84**	**80**	12	**64**	**68**	»	36
Comarum palustre.....	E 4	HH	12	28	4	**76**	**72**	**56**	16	»	28	40	44
Carex Goodenoughii ...	E 3	G	**88**	**76**	32	**100**	**100**	**100**	**96**	**96**	**100**	**100**	**100**
— rariflora.........	A 2	G	28	4	»	**88**	**52**	**88**	**88**	**92**	**92**	44	**64**
— chordorrhiza	A 1	G	»	12	»	12	**72**	4	**88**	**96**	**100**	**100**	**92**
— rostrata	E 3	HH	»	8	»	8	32	4	8	36	**76**	44	28
Eriophorum polystachyum..............	E 4	G	48	28	8	**96**	**76**	**68**	**88**	**52**	**72**	**100**	**80**
Empetrum nigrum.....	E 4	Ch	28	**88**	**56**	**76**	**96**	24	48	**84**	**52**	**92**	**80**
Vaccinium uliginosum .	E 4	Ch	4	**92**	40	**56**	**100**	24	**76**	**100**	**100**	**100**	**88**
Betula nana...........	A 2	Ch	»	»	»	12	16	8	24	**84**	**100**	**100**	**80**
Carex sparsiflora	A 1	G	12	16	20	»	»	»	»	»	»	»	»
— capitata.........	A 2	H	4	4	16	»	»	»	»	»	»	»	
Taraxacum officinale ...	E 2	H	»	24	20	»	8	»	»	»	»	»	»
Luzula multiflora......	E 3	H	16	8	12	4	8	»	»	»	»	»	»
Equisetum pratense....	E 2	G	8	8	28	»	»	»	»	»	»	»	»
— variegatum .	A 3	H	40	12	24	36	20	8	»	»	»	»	»
Galium Normanni	A 1	H	24	36	48	12	4	12	»	»	»	»	»
— boreale........	E 2	H	40	20	28	4	20	16	»	»	»	»	12
Potentilla verna	A 2	H	12	8	16	4	12	»	4	»	»	»	»
Selaginella selaginoides.	A 1	Ch	20	28	40	16	8	4	»	4	4	»	8
Salix glauca	A 3	Ch	8	20	4	8	36	12	16	»	20	4	4

TABLE 15 A CONTINUED.

			1	2	3	4	5	6	7	8	9	10	11
Pingvicula vulgaris	E 4	H	»	»	»	4	4	»	4	8	8	»	16
Scirpus caespitosus	E 4	H	»	»	»	»	»	»	20	40	40	»	8
Menyanthes trifoliata...	E 4	HH	»	»	»	20	»	»	»	12	»	20	36
Agrostis alba	E 3	H	»	»	4	20	»	»	»	»	»	»	
Calluna vulgaris	E 2	Ch	»	12	»	»	»	»	»	»	»	»	»
Carex alpina	A 2	H	12	»	»	»	»	»	»	»	»	»	»
— canescens	E 4	H	»	»	»	16	»	»	4	»	»	»	»
— dioica...........	E 4	G	4	»	»	»	»	4	4	»	»	»	»
— limosa.	E 2	G	»	»	»	»	»	»	»	»	»	»	20
— panicea	E 3	G	»	»	24	»	»	»	»	»	»	»	4
Deschampsia alpina	A 2	H	4	»	»	»	»	»	»	»	»	»	»
— flexuosa ..	E 3	H	»	4	12	»	»	»	»	»	»	»	»
Elyna Bellardi.........	A 3	H	»	»	8	»	»	»	»	»	»	»	»
Equisetum limosum ...	E 2	HH	»	»	»	»	4	»	»	»	»	12	16
Eriophorum Scheuchzeri	A 3	HH	»	»	»	8	»	4	»	8	»	»	8
Euphrasia latifolia	A 2	Th	»	»	»	»	»	4	»	»	»	»	»
Galium verum	E 1	H	»	»	8	»	»	»	»	»	»	»	»
Geum rivale	E 2	H	»	»	»	»	»	8	»	»	»	»	4
Hierochloë odorata.....	E 2	G	40	8	»	»	16	8	»	»	»	»	»
Juncus balticus........	A 1	G	»	»	»	»	4	»	»	»	»	»	»
— filiformis	E 3	G	»	»	4	4	»	»	»	»	»	»	»
— trifidus	A 2	H	4	»	12	»	»	»	»	»	»	»	»
Leontodon autumnalis..	E 3	H	»	4	»	»	»	»	»	»	»	»	»
Luzula spicata	A 2	H	»	»	4	»	»	»	»	»	4	»	»
Poa alpina	A 2	H	8	»	»	»	»	»	»	»	»	»	»
— pratensis..........	E 4	G	»	8	»	8	»	»	»	»	»	»	»
Ranunculus acer.......	E 4	H	»	»	»	»	4	»	»	»	»	»	»
Rhinanthus minor	E 2	Th	4	4	»	»	»	»	»	»	»	»	»
Rumex acetosa	E 3	H	»	»	4	»	»	»	»	»	»	»	»
Spiræa ulmaria	E 2	H	»	»	»	8	»	4	»	»	»	»	4
Thymus serpyllum.....	E 4	Ch	»	4	16	»	»	»	»	»	»	»	»
Tofieldia palustris	A 2	H	»	»	»	»	»	»	»	»	»	»	4
Triglochin palustre	E 4	H	»	»	»	»	4	»	»	»	»	»	
Trisetum spicatum	A 3	H	12	4	»	»	4	4	»	»	4	»	4
Viola canina	E 3	H	»	»	4	»	»	»	»	»	»	»	»

S. lanata. The species common to this formation and those above, and which are not present or only occur sporadically in the moist Betula nana mýri are the following. *Salix herbacea*, *S. lanata*, *Viola palustris*, *Cardamine pratensis*, *Agrostis canina*, *Festuca rubra* and *F. ovina*, and *Equisetum arvense*. The following species are

TABLE 15 B.

Biological Spectra of the Jaðar- and Mýri Vegetation.

	1	2	3	4	5	6	7	8	9	10	11
Points sum	1376	1404	1352	1360	1408	1076	752	1004	1076	888	1032
Number of species	38	42	42	39	38	34	19	21	23	16	35
Density of species	13.8	14.0	13.5	13.6	14.1	10.8	7.5	10.0	10.8	8.9	10.3
A	42 7	34.8	36 4	33.8	39.8	47.2	**50.0**	**52.6**	**51.7**	**40.5**	**40.7**
E	**57.3**	**65.2**	**63.6**	**66.2**	**60.2**	**52.8**	**50.0**	**47.4**	**48.3**	**59.5**	**59.3**
A 3	20.1	15.4	14.5	13.2	15.3	21 2	16.5	17.5	16 0	10 4	10.1
A 2.............	12 2	6.8	9.5	10.6	11.6	16.7	16.5	23.9	24.5	16.2	18.2
A 1.............	10.5	12.5	12.4	10.0	12.8	9.3	17.0	11.2	11.2	14.0	12.4
E 4.............	30.2	39.3	32.2	45.3	39.8	32.7	36.2	33.9	32.0	41.9	39.9
E 3.............	15.4	14.2	12.7	18.8	16.8	16.4	13.8	13.5	16.4	16.2	14.0
E 2.............	**11.6**	**11.7**	**18.0**	2.1	3.6	3.7	»	»	»	1.4	5.4
E 1.............	»	»	0.6	»	»	»	»	»	»	»	»
Ch	12 2	27.6	16.9	21.5	28.7	18.6	**29.3**	**30.7**	**27.5**	**36.0**	**29.5**
H	**52.9**	**45.3**	**61.8**	**38.8**	**29.8**	**34.2**	7.4	15.9	15.2	2.3	15.9
G	33.7	24.2	21.0	**31.5**	**33.8**	**40.9**	**60.1**	**47.8**	**47.6**	**48.6**	**41.9**
HH	0.9	2 6	0.3	8.2	7.7	5.9	3.2	5.6	9.7	13.1	12.8
Th	0.3	0.3	»	»	»	0.4	»	»	»	»	»

common to the dry and the ± moist Cyperaceae mýri. *Carex Goodenoughii*, *C. chordorrhiza*, and *C. rariflora*, besides *Eriophorum polystachyum*. Common to all three formations are *Empetrum nigrum*, *Vaccinium uliginosum*, *Salix phylicifolia*, *Polygonum viviparum*, and *Thalictrum alpinum*.

The Betula nana Mýri. Table 15 A—B, 7—11.

In this formation the change from jaðar to Salix mýri has progressed still further. The number and density of the species is appreciably diminished. H have decreased considerably and G have attained a maximum. The Ch and HH percentages have also risen. The species group spectrum has likewise undergone a change. The quantity of A species has increased somewhat, and in the A subgroups there is displacement from A 3 to A 2 and A 1. The E subgroups show a displacement in the direction of E 4.

Physiognomically chamaephytes and Cyperaceae are dominant, thus of chamaephytes especially *Betula nana*, *Vaccinium uliginosum*,

and *Empetrum nigrum*, and in less degree *Salix phylicifolia*. Of Cyperaceae *Carex Goodenoughii*, *C. chordorrhiza*, *C. rariflora*, and *Eriophorum polystachyum* are particularly conspicuous. To these must be added *Polygonum viviparum* and *Thalictrum alpinum*. Of the marsh plants *Carex rostrata* is the most important. *Comarum palustre*, *Menyanthes trifoliata* and *Equisetum limosum* occur more sporadically.

The Flói Vegetation. Table 16 A—B, 1—5.

The vegetation is not evenly distributed over the surface of the mýri: a number of the species, especially the chamaephytes, are peculiar to the knolls, others, the Cyperaceae, only occur in the spaces between the knolls. Passing from the mýri towards the flói, the spaces between the knolls grow larger and larger until the knolls have quite disappeared and with them their vegetation.

In table 16 A—B are tabulated the circling results for all the lowland localities investigated in Iceland, from Lýngdalsheiði, Björk and Lækjamót. The reason why so few localities were investigated was that the rainy summer of 1925 afforded very poor working conditions. In spite of the few localities, the table gives interesting and mutually agreeing particulars of the flói vegetation. Compared with the mýri vegetation it is very poor in species, the number of species being 2—4, the density 1—2. Geophytes and helophytic Cyperaceae form the bulk of the vegetation, thus especially *Eriophorum polystachyum*, *Carex Goodenoughii*, *C. chordorrhiza* and *C. rostrata*. A few other species occur sporadically.

The greatest interest attaches to the biological conditions when compared with those of the mýri vegetation. The species group spectrum shows a strong concentration in the central part of the spectrum from E 3 to A 1; the lower groups, and in part the upper ones, are not represented in the spectrum.

This spectrum seems to be typical of vegetations on a water-covered surface. The Subularia flag, whose vegetation is covered by a water layer as deep as that of the flói, has practically the same species group spectrum as the flói with a large predominance in the central part of the spectrum. The same is the case with the highland flói.

The statistical and biological conditions of the flói are, as a comparison of the respective tables will show, a further development

TABLE 16 A-B.

The Flói Vegetation in Lyngdalur, at Björk, and at Lækjamót.

1—2 situated in Lyngdalur, 3—4 at Björk, and 5 at the bottom of the valley at Lækjamót. 1—2 examined on 22/7 1925, 3—4 on 27/7 1925, and 5 on 21/8 1925.

			1	2	3	4	5
Carex Goodenoughii	E 3	G	36	**100**	32	**100**	»
— chordorrhiza	A 1	G	»	4	»	**100**	**100**
Eriophorum polystachyum	E 4	G	»	»	4	20	**100**
Carex rostrata	E 3	HH	»	»	**100**	»	»
Ranunculus reptans	E 4	H	**88**	»	»	»	»
Carex rariflora	A 2	G	»	»	»	12	»
— saxatilis	A 3	G	»	»	»	»	4
Comarum palustre	E 4	HH	»	»	4	»	»
Menyanthes trifoliata	E 4	HH	»	»	4	»	»
Number of species	Flag-		2	2	5	4	3
Density of species	vegetation[1]		1.2	1.0	1.4	2.3	2.0
A	»	28.2	»	3.8	»	48.3	51.0
E	**100**	**71.8**	**100.0**	**96.2**	**100.0**	51.7	49.0
A 3	»	28.2	»	»	»	»	2.0
A 2	»	»	»	»	»	5.2	»
A 1	»	»	»	3.8	»	**43.1**	**49.0**
E 4	23.3	18.4	**71.0**	»	8.3	8.6	**49.0**
E 3	**76.7**	**53.5**	29.0	**96.2**	**91.7**	**43.1**	»
E 2	»	»	»	»	»	»	»
E 1	»	»	»	»	»	»	»
H	10.0	11.2	**71.0**	»	»	»	»
G	23.3	12.7	29.0	**100.0**	25	**100.0**	**100.0**
HH	»	»	»	»	**75**	»	»
Th	**66.7**	**76.1**	»	»	»	»	»

of the changes occurring in the mýri formations from the comparatively dry to the comparatively wet formations.

The Flag Vegetation. Cf. figs. 12—13 and table 17 A—B.

On the border line between mo and mýri are often found long narrow strips of land called "flag" in Icelandic. In a floristic and physiognomic respect the flag deviates much from the surrounding mo or mýri, and by its mixture of pronounced arctic (A 3) and

[1] Cf. table 17 B 1-2.

pronounced southern (Th) types of plants it is one of the most remarkable and interesting vegetations of Iceland.

The flag occurs as from 2—3 to 15—20 m. wide and often very long clayey flats delimited upwards towards the mo by a more or less connected slope and outwards towards the mýri by a connected ridge (cf. figs. 11—12). The soil of the flag is level and horizontal. If covered with water the whole of the summer it is a naked clayey flat without any trace of knolls. If such a flat is laid dry, the familiar polygonal cracks appear. If the soil is not covered with water in the summer, it will always be cracked, and a greater or smaller number of small knolls covered with vegetation will be spread over the surface. Such is the typical appearance of the flag. If the soil grows drier still, the knolls increase in number as well as in size and we get the flag mo, though the bare clay surface still predominates.

The flag vegetation seems to comprise a number of formations. Table 17 A shows the circling results for three such formations, the Subularia flag, the Koenigia flag, and the flag mo.

The Subularia flag was examined in a single locality, the mýri at Björk. Here a long strip of Koenigia flag occurred in connection with a small brook. The Subularia flag was found at the transition from the Koenigia flag to the brook. At the time when the investigation was made, (the close of July), the soil was covered with water. In the deepest water only scattered specimens of *Subularia aquatica* were found (table 17 A, 1), while further in (table 17 A, 2) it was found in company with some other species such as *Koenigia islandica, Juncus bufonius, Equisetum arvense.*

From East Iceland a formation has been recorded by Helgi Jónsson which must probably be referred to the flag. "Where the soil has an admixture of clay little pools are formed in the depressions which evaporate in the course of the summer. In these places the vegetation varies not a little, consisting now almost exclusively of *Subularia aquatica*, now on the other hand only of *Ranunculus reptans* which colours such spots quite yellow. I have seen both species occur in such quantities that they coloured the whole bottom of the pool white or yellow. In other places I saw that the vegetation consisted of *Ranunculus reptans, Subularia aquatica, Alopecurus fulvus* and *Juncus supinus* fairly equally distributed, so that neither one nor the other could be designated as the characteristic plant."

TABLE 17 A.

The Flag Vegetation at Björk and Lækjamót.

Localities 1—5 situated in South Iceland at Björk c. 100 m above sea level. 1—2 Subularia flag; 3—5 Koenigia flag; 6—7 flag mo from North Iceland, Lækjamót, c. 50 m above sea level. 1, 2, and 5 examined on $^{25}/_{7}$ 1925, 3 on $^{18}/_{7}$, and 4 on $^{21}/_{7}$ 1925; 6—7 on $^{20}/_{8}$ 1925. (25. $^{1}/_{10}$ m^{2}).

			1	2	3	4	5	6	7
Subularia aquatica	E 3	Th	**80**	**76**	»	»	»	»	»
Koenigia islandica	A 3	Th	»	**80**	**100**	**100**	**100**	**100**	**100**
Juncus bufonius	E 3	Th	»	**60**	**76**	**96**	**64**	»	»
Sedum villosum	A 2	H	»	»	**96**	**100**	**100**	**88**	**84**
Agrostis alba	E 3	H	12	16	**92**	**100**	**96**	**96**	**88**
Juncus triglumis	A 3	H	»	»	**76**	**68**	36	**64**	**68**
— biglumis	A 3	H	»	»	48	36	36	48	**88**
Triglochin palustre	E 4	H	»	16	**88**	**68**	**68**	**68**	32
Polygonum viviparum	A 3	G	»	»	**72**	**76**	**76**	**88**	**68**
Equisetum arvense	E 4	G	28	36	44	48	36	**52**	28
Sagina nodosa	E 3	H	»	»	48	**60**	24	**52**	**56**
Festuca ovina	E 4	H	»	»	28	36	20	36	32
Deschampsia alpina	A 2	H	»	»	8	40	4	28	28
Luzula spicata	A 2	H	»	»	24	12	48	**72**	**80**
Minuartia verna	A 3	Ch	»	»	20	36	12	»	»
Cerastium caepitosum	E 3	Ch	»	»	24	**60**	»	**88**	**60**
— alpinum	A 3	Ch	»	»	»	»	48	48	**56**
Silene acaulis	A 3	Ch	»	»	»	»	»	20	40
Armeria vulgaris	A 3	Ch	»	»	»	»	»	24	24
Rumex acetosa	E 3	H	»	»	»	»	»	40	16
Poa alpina	A 2	H	»	»	»	»	»	28	8
— glauca	A 3	H	»	»	»	»	»	4	12
Thalictrum alpinum	A 2	H	»	»	4	»	»	28	12
Parnassia palustris	E 2	H	»	»	»	»	»	28	4
Carex capillaris	A 3	H	»	»	»	»	»	20	8
Pingvicula vulgaris	E 4	H	»	»	»	»	»	8	4
Agrostis tenuis	E 2	H	»	»	»	»	8	»	»
Arenaria ciliata	A 3	Ch	»	»	»	»	»	»	20
Cardamine pratensis	E 4	H	»	»	8	»	»	»	»
Draba incana	A 2	H	»	»	»	»	»	8	»
Empetrum nigrum	E 4	Ch	»	»	4	4	»	4	»
Epilobium alsinifolium	A 1	H	»	»	»	4	»	»	»
Equisetum pratense	E 2	G	»	»	4	»	4	»	»
Euphrasia latifolia	A 2	Th	»	»	»	»	»	»	4
Festuca rubra	E 4	H	»	»	»	»	24	4	»

TABLE 17A CONTINUED.

			1	2	3	4	5	6	7
Juncus trifidus..........	A 2	H	»	»	»	»	»	»	8
Leontodon autumnalis...	E 3	H	»	»	»	»	»	8	»
Linum catharticum	E 1	Th	»	»	»	8	»		
Potentilla verna.........	A 2	H	»	»	»	»	»	4	»
Rhinanthus minor.......	E 2	Th	»	»	»	»	4	»	
Salix herbacea	A 3	Ch	»	»	16	»	»	»	»
Saxifraga oppositifolia ...	A 3	Ch	»	»	»	»	»	»	4
Spergula arvensis	E 2	Th		»		8	»		»
Taraxacum officinale	E 2	H	»	»	»	»	»	»	4
Thymus serpyllum	E 4	Ch	»	»	»	»	4	»	4
Viola palustris	E 3	H	»	»	4	»	»	»	»

TABLE 17B. **Biological Spectra of the Flag Vegetation.**

	1	2	3	4	5	6	7
Points sum	120	284	884	960	812	1156	1040
Number of species	3	6	21	19	20	29	29
Density of species..........	1.2	2.8	8.8	9.6	8.1	11.6	10.4
A	»	28.2	**52.5**	**49.2**	**56.7**	**58.1**	**68.5**
E	**100.0**	**71.8**	**47.5**	**50.8**	**43.3**	41.9	31.5
A 3........................	»	28.2	**37.6**	**32.9**	**37.9**	**36.0**	**46.9**
A 2........................	»	»	14.9	15.8	18.7	22.1	21.5
A 1........................	»	»	»	0.4	»	»	»
E 4........................	23.3	18.4	19.5	16.2	18.7	14.9	9.6
E 3........................	**76.7**	**53.5**	27.6	32.9	22.6	24.6	21.2
E 2........................	»	»	0.5	0.9	2.0	2.5	0.8
E 1........................	»	»	»	0.9	»	»	»
Ch	»	»	7.2	10.4	7.9	15.9	20.0
H	10.0	11.2	**59.3**	**54.6**	**57.1**	**63.3**	**60.8**
G	23.3	12.7	13.6	12.9	14.3	12.1	9.2
HH	»	»	»	»	»	»	»
Th	**66.7**	**76.1**	**19.9**	**22.1**	**20.7**	8.7	10.0

I have seen both these formations, the Subularia and the Ran. reptans formation, in the south country, and I can confirm Helgi Jónsson's statement that they occur on a water-covered soil. The

Subularia formation has been described above, the Ran. reptans formation under the flói (p. 70). There seems, however, to be no little difference between the environment of these two formations. The Subularia formation is found where the motion of the water (temporarily or continually?) is so strong that it causes a shifting of the bottom material, in the Ran. reptans formation it is less strong and no shifting takes place. As the third link in the chain we have the flói; here the water is stagnant and the bottom covered with mosses.

All three formations have but a small density of species and practically the same species group spectrum, a high E percentage and concentration in the central part of the spectrum. The biological spectrum is of special interest. In the Subularia formation Th are dominant, in the R. reptans formation H, and in the flói G.

The Koenigia flag and the flag mo represent the flag vegetation proper. The circling results are tabulated in table 17 A, 3—7.

Nos. 3—5 show the composition of the vegetation on flag at Björk in the south country. The dominant species are in the first place *Koenigia islandica* and *Sedum villosum*. Further *Agrostis alba* and *Juncus* spp. abound, *J. bufonius*, *J. triglumis*, *J. biglumis*, *Triglochin palustre*, *Polygonum viviparum*, *Equisetum arvense*, *Sagina nodosa*, *Minuartia verna*, *Cerastium alpinum*, *C. cæspitosum*, *Deschampsia alpina*, *Festuca ovina*, and *Luzula spicata*. The table gives more precise information as to the part played by the individual species and the variation from locality to locality. Sporadically a number of plants occur which mostly originate from the surrounding formations, jaðar and mo.

Nos. 6—7 represent the flag mo at Lækjamót in the north country. The dominant species are practically the same here (though *Juncus bufonius* was absent in the north country), and the individual species occur with almost the same F.-percentage. An essential difference between the flag mo and the Koenigia flag is due to the presence of a quantity of mo plants in the flag mo, thus especially *Thalictrum alpinum*, *Rumex acetosa*, *Poa alpina* and *P. glauca*, *Parnassia palustris*, *Armeria vulgaris*, *Carex capillaris*, *Silene acaulis* and several others. Another marked difference between the flag mo and the Koenigia flag is the great number of little knolls found in the former.

The individual species are differently distributed over the surface, some species being associated with the clayey soil others with the knolls. On the clayey soil the vegetation is open, and here we

principally or exclusively find such species as *Koenigia islandica*, *Sedum villosum*, *Juncus bufonius*, *biglumis* and *triglumis*, *Triglochin palustre*, *Equisetum arvense*, *Cerastium cæspitosum*, *Sagina nodosa*, *Minuartia verna*. On the small knolls the vegetation is connected and here we find the species *Agrostis alba*, *Deschampsia alpina*, the *Festuca* spp., *Armeria vulgaris*, *Rumex acetosa* and several others, principally such as are common to mo and jathar.

Helgi Jónsson was the first to describe the flag vegetation, though without thus naming it. His description of the vegetation on the "clayey flats" which is referred to the "open vegetation of the lowlands" corresponds to the description given above of the flag vegetation. In "Studier over Øst Islands Vegetation" 1895, p. 86, he says, "they (i. e. the clayey flats) have most frequently a monotonous vegetation consisting of *Sedum villosum*, *Koenigia islandica*, *Juncus triglumis* and other more casually growing plants. This vegetation on clay varies not a little in composition; of the forms I have seen, I note especially the following: a. The vegetation consists only of *Sedum villosum* which occurs in a rather dense growth and gives a fresh appearance to the clayey flats by its pretty flowers. b. The vegetation consists only of *Koenigia islandica* which also occurs in a rather dense growth but in this locality it is most frequently of a red colour. c. The vegetation consists of *Sedum villosum* and *Koenigia islandica* either in equal quantities or with now one, now the other as the dominant. d. The vegetation consists of *Juncus triglumis* as the dominant plant, besides scattered individuals of *Sedum villosum* and *Koenigia islandica*, and *Agrostis alba* in scattered tufts."

"It should be noted that in many places a transition to the mo vegetation is seen where most of the species of the mo occur (*Gramineae*, *Juncaceae*) growing in scattered tufts with bare clay between, it is merely a younger stage of the grass mo."

In "Vegetationen paa Snæfellsnæs" 1900, pp. 43—44, we read: "Plants characteristic of the clayey flats are *Sedum villosum*, *Koenigia islandica*, *Juncus alpinus* and *J. triglumis*. The two first-mentioned are most prominent and often occur in an astonishing quantity. The most frequently occurring species are *Agrostis alba*, *Aira alpina*, *Sagina nodosa*, *Triglochin palustre*, *Epilobium palustre*, *Luzula spicata*, *L. multiflora*. In East Iceland this vegetation had quite the same appearance. When these flats dry up in the summer, they are often divided by cracks into many small polygonal areas,

lozenges, the surface contracting so much owing to the disappearance of the water that it cracks. On the flats here described these are of very different duration, most frequently they last a very short time, disappearing when the surface becomes damp again. For the vegetation these cracks, as far as I can see, are of no importance, since it nearly always occurs on the lozenges themselves."

In "Vegetationen paa Syd Island", 1905, pp. 13—14, he writes, "Open clayey flats are met with in many places." "The vegetation on the clayey flats is always very poor in species, and only where the vegetation of the clayey flats is passing into the surrounding associations do we meet with a greater abundance of species. The typical clayey flats as a rule contain the same species everywhere. The few species which are exclusively or principally found on the clayey flats and must thus be designated as characteristic of them are the following: *Sedum villosum, Koenigia islandica, Spergula arvensis, Juncus alpinus, J. triglumis.* The most commonly occurring are *Agrostis alba, Juncus bufonius, Equisetum arvense, Epilobium palustre, Poa annua, Stellaria crassifolia, St. media, Cerastium vulgare, Polygonum aviculare, Sagina procumbens.* More rarely we meet with *Triglochin palustre, Alopecurus fulvus, Scirpus pauciflorus, Eriophorum Scheuchzeri, Sedum annuum, Poa glauca, Rumex acetosa, Silene maritima, Phleum alpinum, Myosotis arvensis, Veronica serpyllifolia, Rumex acetosella, Thymus serpyllum, Leontodon.*"

By the above quotations from H. Jónsson's descriptions of the vegetation and by the circling results given here the flag vegetation has been characterised floristically. If we are to characterise the vegetation biologically, the best way will be to compare the biological spectra of the flag and the neighbouring vegetations, i. e. the mo and the jaðar. Table 18 gives the biological spectra of these types of vegetation at Björk and Lækjamót, viz. respectively moist mo, flag (or flag mo), jaðar (or mýri).

It will appear from the table that the flag vegetation is poorer in species and shows less density of species than the surrounding types of vegetation, the mo and the jaðar. This applies especially to the Koenigia flag. As regards the content of Raunkiær's life forms, the flag is especially remarkable by its high Th percentage. As shown above, the Subularia flag had a Th percentage of 71, the Koenigia flag a Th percentage of 20.9, and the flag mo a Th percentage of 9.4. The table likewise shows a comparatively high H percentage and comparatively low Ch and G percentages. The pro-

TABLE 18. **Biological Conditions in Mo, Flag, and Jaðar at Björk (I) and Lækjamot (II).** Cf. the text.

a	Number of species	Density of species	Ch	H	G	Th
I. Moist mo	**39.7**	**14.8**	**28.9**	52.3	**18.3**	0.1
Flag	20.0	8.8	8.5	**57.0**	13.6	**20.9**
Jaðar	**42.0**	**13.8**	**22.3**	53.6	**24.1**	0.2
II. Moist mo	**42.5**	**15.9**	**24.7**	58.0	**14.1**	3.3
Flag mo	29.0	11.0	18.0	**62.1**	10.7	**9.4**
Mýri vegetation	**33.0**	**11.2**	12.5	39.9	**45.9**	2.1

b	A	E	A 3	A 2	A 1	E 4	E 3	E 2	E 1
I. Moist mo	39.3	**60.7**	19.3	9.6	**10.4**	**32.6**	10.8	**16.8**	0.5
Flag	**52.8**	47.2	**36.1**	**16.5**	0.1	18.1	**27.7**	1.1	0.3
Jaðar	35.6	**64.4**	15.0	8.2	**12.5**	**35.8**	13.5	**14.9**	0.3
II. Moist mo	56.5	**43.5**	32.6	15.9	**8.0**	**22.6**	10.2	**8.8**	2.0
Flag mo	**63.3**	36.7	**41.5**	**21.8**	»	12.3	**22.9**	1.7	»
Mýri vegetation	50.0	**50.0**	22.6	25.1	**2.3**	**24.6**	16.5	**8.7**	

portion of Th, G, and H is no doubt directly dependent on the comparatively strong desiccation of the flag in the summer.

On passing from the mo to the mýri on gently sloping ground, in places where no flag vegetation has been developed, there will, as will be shown in more detail later on, occur a decrease of the Ch percentage and an increase of the H, Th, and G percentages at the level answering to the flag zone. Apart from the geophytes this is the same change as characterised the flag vegetation. *Hence the flag vegetation must not be regarded as such an isolated phenomenon as its physiognomy and peculiar biology would seem to suggest at a first glance, it must be regarded as an extreme stage of development of those conditions of environment which are found and act in the stage of moisture with which the flag vegetation is associated.*

If we consider the species group spectrum, here, too, we shall find a peculiar difference between the flag vegetation and the surrounding types. The proportion of arctic plants is comparatively high in the flag, and this is due to a rise in the A 3 and A 2 per-

centages, while the A 1 species are practically absent. In the E subgroups the peculiarity appears in the fact that the decrease comes especially under E 2 and likewise in no small degree under the E 4 species, while the E 3 percentage is considerably higher than in the surrounding types of vegetation, mo and jaðar or mýri. Both the localities examined, the south country as well as the north country, show the same deviation from the adjacent types of vegetation with regard to the species group spectra. The flag vegetation is thus characterised by comparatively high A 3, A 2, and E 3 percentages, and by comparatively low A 1, E 4, and E 2 percentages.

As regards the distribution of the flag vegetation it may be said that in Iceland it seems to be peculiar to the lowlands alone. Personally I have sought the flag vegetation in vain in the highland tracts of South Iceland (Lýngdalsheiði), of Arnarvatnsheiði and Holtavörðuheiði (Tvidägra). Magister Pálmi Hannesson, who has explored the highlands for a number of years, has informed me orally that a flag vegetation has never been observed here. Helgi Jónsson refers the clayey flats (i. e. the flag vegetation) to the "open vegetation of the lowlands" (it is not mentioned that they only occur in the lowlands). If we may infer from this that the clayey flats have not been seen by Helgi Jónsson in the highlands, all observations would seem to indicate that the flag vegetation is limited to the lowlands.

In Iceland the flag vegetation has been observed in all parts of the country. As mentioned above, H. Jónsson has described it from East Iceland, South Iceland, and South-West Iceland. On my journey in the summer of 1925 I observed flag vegetation in the south country (at the foot of Lýngdalsheiði) in the south-west country (Norðtunga in Borgarfjörður), and in the north country (Lækjamót in Viðidalur). According to the oral communication of Mr. Jacob Lindal, the farmer at Lækjamót, who has travelled through the north country as consulting agriculturalist for a number of years, the flag vegetation is of common occurrence throughout this part.

Judging from the literature, the flag vegetation seems to be peculiar to Iceland. I have not been able to find in the phytogeographical literature on the surrounding countries any record of types of vegetation which may be compared with or referred to the flag vegetation in its typical form.

Hence the flag vegetation seems to be a type of vegetation peculiar to the Icelandic lowlands.

The special association of the flag vegetation with the Icelandic lowlands is, however, probably more apparent than real, for the flag vegetation seems to be a northerly, highly specific offshoot of a series of peculiar Th formations which are met with in Denmark, too, on moderately moist soil. These Th formations have not, however, been more closely investigated though they had early attracted the attention of botanists by their peculiar flora. The following are some of the most characteristic species: *Radiola milligrana*, *Linum catharticum*, *Scirpus setaceus*, *Centunculus minimus*, *Myosurus minimus*, *Gnaphalium uliginosum*, a number of small *Juncus* spp. *J. bufonius*, *J. tenuis*, *J. capitatus*, and *J. pygmæus*, besides *Bulliarda aquatica*. On slightly damper soil we meet with species such as *Subularia aquatica*, *Pilularia globulifera*, *Elatine hexandra*, *Montia* spp., *Ranunculus reptans*, *Juncus supinus*, *Peplis portula*, *Limosella aquatica*. This flora is especially met with on dunes, on damp moors, or in badly cultivated rye fields, and occurs frequently at any rate in western Jutland. In meadows, especially littoral meadows, in addition to a number of species already mentioned, we meet with a number of *Gentiana* spp., *Rhinanthus*, *Euphrasia*, *Odontites*, and *Sagina* species. Even in damp birch woods Th formations may be met with consisting of *Geranium Robertianum* and *Impatiens noli tangere*.

However, it is not only the characteristic life form that is common to the Danish Th formations on soil of moderate moisture and the Icelandic flag, they have also a number of species in common; thus the following species recorded from the flag are found in Denmark in company with the above-mentioned species. *Ranunculus reptans*, *Subularia aquatica*, *Juncus bufonius*, *J. supinus*, *Triglochin palustre*, *Agrostis alba*, *Equisetum arvense*, *Sagina nodosa*, *Parnassia palustris*, *Linum catharticum*, *Rhinanthus minor*, *Spergula arvensis*, *Stellaria media*, *Scirpus pauciflorus*.

A comparison of these lists may perhaps be of aid in tracing the forces which give rise to the flag in Iceland. The causes for the occurrence of the Th formations on moderately moist soil in Denmark must be sought partly in fluctuations in the level of the water, partly in the frost phenomena present here and resulting in crumbling and aeration of the soil. When the moderately moist Th formations attain their finest development in the Icelandic lowlands which are sub-arctic and Atlantic in character, this must no doubt be due to a corresponding increase in these factors, especially the frost phenomena.

C. LÆKJAMÓT (THE NORTH COUNTRY).

With the farm Lækjamót as my starting point I had an opportunity of studying the vegetation in a valley in North Iceland for some days in the middle of August 1925. The principal types of vegetation are the same here as in the south country, viz. melar, mo, and mýri. The following applies to their distribution. Up the sides of the valley, at the top only the melar vegetation is met with, lower down there occurs a belt in which the mo prevails with spots of melar, but devoid of mýri, and at the foot there is a belt where the mýri vegetation is dominant and where mo and melar are only found over small areas. In the bottom of the valley the depressions are occupied by the mýri vegetation, the more elevated areas by melar and mo. Along the banks of the rivers the vegetation consists mainly of jaðar. Between the vegetation of the valley sides and that of the valley bottom there is the essential difference that the mýri vegetation of the valley sides consists exclusively of halla mýri (well mýri), while in the valley bottom it consist exclusively of fórmýri (swampy mýri). On the boundary line between mo and mýri, flag mo was met with, both on the valley floor and on the sides of the valley.

Such is the appearance of a transverse section of a vally in North Iceland. Unfortunately time did not permit me to investigate a longitudinal section. What I have seen fragmentarily would seem to show that at any rate the floor of the valley exhibits typical and interesting differences, especially as regards the mýri vegetation. At the head of the valley, where there was no level bottom, the halla mýri (including the dý vegetation) extended right down to the river. This was the case at Aðalbol in the Austerádalur. Further out, as at Lækjamót in the Viðidalur, halla mýri is only found on the mountain slopes, while the level bottom of the valley is covered with the fórmýri (including the flói vegetation). Still further out the fórmýri seems to have been replaced by the fétmýri, the Carex cryptocarpa mýri (including the fen vegetation, the Equisetum limosum swamp). This at any rate was the case at the mouth of the Vatnsdalur.

Tables 19 A and 20 A show the circling results for melar, mo, and mýri in the neighbourhood of Lækjamót. The circling results for the flag mo are given in table 17 A together with the flag vegetation from the south country.

Table 19 a. **The Melar and Mo Vegetation at Lækjamót.**

1—3 the melar vegetation, 4—7 the mo vegetation, 4—5 the comparatively dry mo, 6—7 the comparatively moist mo. Localities 1, 5, and 7 are situated at the bottom of the valley N.W. of Lækjamót c. 50 m above sea level; 2, 3, 4, and 6 on the valley slope on the western side of Víðidalsfjall, directly east of Lækjamót c. 75 m above sea level. 4 and 6 were examined on $^{19}/_{8}$ 1925, 1, 2, 3, 5, and 7 on $^{20}/_{8}$ 1925. (1. 20. $^{1}/_{10}$ m², 2—7. 25. $^{1}/_{10}$ m²).

			1	2	3	4	5	6	7
Arabis petræa	A 1	Ch	5	12	8				
Arenaria ciliata	A 3	Ch	10	16	8	»	»	»	
Minuartia verna	A 3	Ch	25	32	12	»	»	»	
Saxifraga oppositifolia	A 3	Ch	10	36	**60**	»			
Dryas octopetala	A 3	Ch	5	44	40	**96**	**72**	**60**	
Thymus serpyllum	E 4	Ch	**50**	**56**	**56**	**84**	**92**	**68**	**52**
Armeria vulgaris	A 3	Ch	10	16	16	44	24	28	8
Silene acaulis	A 3	Ch	**50**	**52**	**60**	**72**	**52**	40	28
Cerastium alpinum	A 3	Ch	**50**	**56**	44	40	16	**56**	16
Luzula spicata	A 2	H	45	48	48	**64**	**60**	44	48
Poa glauca	A 3	H	25	**60**	44	24	24	24	16
Festuca ovina	E 4	H	**50**	44	44	28	32	48	**68**
— rubra	E 4	H	5	40	**52**	**96**	**88**	**84**	**96**
Agrostis canina	E 3	H	5	12	8	**68**	**92**	**80**	**92**
Galium Normanni	A 1	H	10	20	48	32	**60**	**72**	**64**
Euphrasia latifolia	A 2	Th	10	20	20	44	16	28	24
Salix herbacea	A 3	Ch	»	4	20	**52**	**80**	**56**	**60**
Selaginella selaginoides	A 1	Ch	»	12	16	**60**	**52**	48	36
Juncus trifidus	A 2	H	»	8	20	44	**60**	**60**	40
Elyna Bellardi	A 3	H	»	24	12	**80**	**92**	**68**	**88**
Carex capillaris	A 3	H	»	44	28	**68**	**92**	**76**	40
Polygonum viviparum	A 3	G	»	**52**	48	**100**	**96**	**100**	**80**
Thalictrum alpinum	A 2	H	»	32	40	**96**	**92**	**100**	**64**
Trisetum spicatum	A 3	H	»	12	24	»	40	4	24
Tofieldia palustris	A 2	H	»	4	24	**52**	36	8	8
Empetrum nigrum	E 4	Ch	»	4	»	**88**	**96**	**72**	**52**
Vaccinium uliginosum	E 4	Ch	»	»	»	**56**	**80**	**68**	28
Equisetum arvense	E 4	G	»	4	4	20	40	28	20
— pratense	E 2	G	»	8	»	24	**52**	24	32
Carex rigida	A 3	G	»	»	4	**60**	48	**80**	44
Luzula multiflora	E 3	H	»	»	»	28	12	32	24
Poa alpina	A 2	H	»	»	»	16	4	40	12
Pingvicula vulgaris	E 4	H	»	»	4	12	40	8	12
Rumex acetosa	E 3	H	»	»	»	8	8	40	4
Deschampsia caespitosa	E 2	H	5	»	»	4	»	**52**	36
Carex sparsiflora	A 1	G	»	»	»	»	12	4	16
Agrostis alba	E 3	H	»	»	»	4	»	»	»
— tenuis	E 2	H	»	»	»	»	»	»	8

TABLE 19 A CONTINUED.

			1	2	3	4	5	6	7
Anthoxanthum odoratum.	E 3	H	»	»	»	»	»	8	»
Bartschia alpina	A 2	H	»	»	»	16	»	4	»
Betula nana	A 2	Ch	»	»	»	4	8	8	»
Botrychium Lunaria.....	E 4	G	»	»	»	»	»	»	8
Carex alpina	A 2	H	»	»	»	»	»	»	4
Cerastium caespitosum ..	E 3	Ch	»	»	»	8	»	4	»
Deschampsia flexuosa....	E 3	H	»	»	»	»	»	»	12
Draba incana	A 2	H	5	»	»	»	»	4	8
Equisetum variegatum...	A 3	H	»	4	4	**60**	»	40	»
Galium verum	E 1	H	»	»	»	»	»	»	36
— boreale	E 2	H	»	»	»	»	»	»	**56**
Gentiana aurea	A 1	Th	»	»	»	4	»	»	»
— campestris	E 1	H	»	4	»	»	4	»	20
— tenella.........	A 2	Th	»	»	»	»	»	»	4
Habenaria viridis	A 1	G	»	»	»	24	»	12	»
Koenigia islandica.......	A 3	Th	»	»	8	»	»	»	»
Parnassia palustris	E 2	H	»	»	4	**52**	»	16	
Plantago maritima	E 4	H	»	»	»	4	»	»	»
Rhinanthus minor	E 2	Th	»	»	»	16	»	**52**	»
Rumex acetosella........	E 4	H	**65**	»	»	»	»	»	»
Sagina nodosa	E 3	H	»	»	»	4	12	»	4
Salix glauca	A 3	Ch	»	»	»	20	16	»	8
Sedum villosum	A 2	H	»	»	»	»	4	»	»
Silene maritima.........	A 1	Ch	10	»	»	»	»	»	»
Viola canina............	E 3	H	»	»	»	»	»	»	12
— palustris	E 3	H	»	»	»	»	»	»	8

The Melar Vegetation. Cf. Table 19 A, 1—3.

Locality No. 1 represents the vegetation in an area of the bottom of the valley at Lækjamót, swept bare by the wind; Nos. 2 and 3, on the other hand, are from the foot of Viðidalsfjall. In all three localities the vegetation was open, not covering the substratum entirely; in No. 1 the surface was covered with gravel and stones without any appreciable trace of solifluction, in Nos. 2 and 3, on the other hand, there was polygonal formation and solifluction.

Compared with the mo vegetation, the Ch, A, and especially the A 3 species play a comparatively prominent part, whereas G and the lower E sub-groups are very sparsely represented. The most conspicuous species are *Cerastium alpinum*, *Silene acaulis*, *Armeria vulgaris*, *Thymus serpyllum*, *Dryas octopetala*, *Luzula spicata*, *Festuca ovina* and *rubra*, *Poa glauca*, *Agrostis canina*, *Euphrasia latifolia*,

TABLE 19 B.

Biological Spectra of the Melar- and Mo Vegetation at Lækjamót.

	1	2	3	4	5	6	7
Points sum	450	780	828	1776	1704	1748	1420
Number of species	20	30	31	42	36	41	44
Density of species	4.5	7.8	8.3	**17.8**	**17.0**	**17.5**	**14.2**
A	**60.0**	**77.9**	**79.2**	**66.0**	**62.0**	**60.0**	**52.1**
E	40.0	22.1	20.8	**34.0**	**38.0**	**39.1**	**47.9**
A 3	**41.1**	**57.9**	**52.2**	40.3	38.3	36.2	29.0
A 2	13.3	14.4	18.4	18.9	16.4	16.9	14.9
A 1	5.6	5.6	8.7	6.8	7.3	7.8	8.2
E 4	38.9	19.0	19.3	21.8	27.5	21.5	23.7
E 3	1.1	1.5	1.0	6.8	7.3	9.4	11.0
E 2	»	1.0	0.5	5.4	3.1	8.2	9.3
E 1	»	0.5	»	»	0.2	»	3.9
Ch	**50.0**	**43.6**	**41.1**	35.1	34.5	29.1	20.3
H	**47.8**	**45.6**	**48.8**	**48.4**	**50.0**	**52.2**	**63.7**
G	»	8.2	6.8	12.8	14.6	14.2	14.1
HH	»	»	»	»	»	»	»
Th	2.2	2.6	3.4	3.6	0.9	4.6	2.0

Galium Normanni, Saxifraga oppositifolia, Arenaria ciliata, Minuartia verna, and *Arabis petræa.* The last four species are only found in melar, the others also in the mo where, however, their physiognomic effect is obscured by more dominant plants.

Of species peculiar to the melar vegetation at Lækjamót we may especially mention *Rumex acetosella* and *Silene maritima,* while the following species are characteristic of the melar at Víðidalsfjall: *Salix herbacea, Selaginella selaginoides, Juncus trifidus, Elyna Bellardi, Carex capillaris, Trisetum spicatum. Polygonum viviparum, Tofieldia palustris,* and *Thalictrum alpinum.* None of these species are specific to melar, they may all be found in the surrounding mo formations.

The Mo Vegetation. Table 19 A, 4—7.

On the mo vegetation I was able to analyse 4 localities, 2 at high and 2 at low levels, one set at the bottom of the valley and one on the slope.

The surface of the mo is knolly here as elsewhere, but the top

of the knolls, especially on the side facing the sea (north), had sometimes been deprived of its carpet of vegetation, exposing the loose interior of the knoll to the desiccating and eroding action of the wind. Hence large areas of the valley bottom have been transformed into barren stretches of gravel covered with the melar vegatation described above.

The number and density of species — especially the latter — are comparatively high in the mo both in comparison with the surrounding vegetations and with the mo vegetation in other parts of Iceland. The greatest density hitherto demonstrated, viz. 17.8, was found on the mountain slopes of Viðidalsfjall. H play a very prominent part in the composition of the vegetation, while Ch have decreased. The G percentage has increased while the Th percentage is unaltered, c. 3. The species group spectrum shows a change in the same direction. The A and especially the A 3 species have decreased in quantity, whereas the E species, especially the lower subgroups, have increased.

Even if the chamaephytes are of subordinate importance in respect of species and points, species such as *Dryas octopetala, Empetrum nigrum, Vaccinium uliginosum,* and *Thymus serpyllum* are physiognomic. Of other dominant chamaephytes we may mention *Cerastium alpinum, Silene acaulis, Armeria vulgaris,* and *Salix herbacea.* Grasses and cyperaceous plants play a very prominent part, especially *Elyna Bellardi*; further *Luzula spicata, L. multiflora, Juncus trifidus, Carex capillaris, C. rigida*, and *C. sparsiflora*, *Festuca ovina* and *F. rubra, Poa glauca* and *P. alpina, Agrostis canina*, and *Trisetum spicatum.* Of herbaceous plants we find especially *Polygonum viviparum,* and *Thalictrum alpinum,* further *Rumex acetosa, Tofieldia palustris, Pingvicula vulgaris,* and *Galium Normanni*; of pteridophytes *Selaginella selaginoides* and *Equisetum* spp., thus *Equisetum arvense, E. pratense,* and *E. variegatum.* The Th are *Euphrasia latifolia, Rhinanthus minor,* and *Gentiana* spp.

Some floristic differences may be shown to exist between the different types of mo. In the low mo *Deschampsia cæspitosa* will always be met with; even though the F.-percentage is not very high, the species is physiognomically fairly predominant. *Carex sparsiflora* is also more frequently met with in the low mo than at higher levels.

In the mo of the valley slopes the following species not found at the bottom are met with. *Equisetum variegatum*, *Rhinanthus minor, Habenaria viridis*, *Parnassia palustris*, and *Bartschia alpina.*

It is chiefly these species which cause the greater density of species on the valley slopes.

Biological differences also occur. Thus the Ch percentage is higher in the high than in the low mo, whereas the reverse is the case with the H percentage. The high E percentage of locality No. 7 is due to a deeper and more constant snow-covering in the winter.

The Mýri Vegetation. Cf. table 20 A, 1—7.

Owing to the short time at disposal only a very few of the mýri formations were investigated; these were a series of moist formations in the halla mýri (1—5), and a couple of formations in the fórmýri (6—7).

The halla mýri is only found along the foot of mountains, and it is essential to its occurrence that the ground-water comes to the surface. This causes a peculiar difference between the halla mýri (well mýri) and the fórmýri (swampy mýri). In the fórmýri the amount of moisture is determined by the precipitation on and around the depressions in the mýri; the quantity of nutrition supplied by the precipitation is comparatively small or nil, just as also the temperature conditions are relatively closely dependent on the temperature of the air. In the halla mýri the nutrient salts are constantly renewed by the ground water, the temperature of which will more or less influence the temperature of the soil according to its amount. The temperature of the ground water is constant throughout the year, that is to say, it is equal to the mean annual temperature in the locality in question. Thus the halla mýri will be warmer in the winter but cooler in the summer than the swampy myri. As a result the species group spectra differ widely. The lower E sub-groups (E 3 and E 2) dominate in the halla mýri owing to the favourable temperature conditions in the winter (!) and A 2 and A 3 species owing to the cool summer soil (!), while the A 1 species are peculiar to the flói of the fórmýri.

Owing to the larger amount of nutrition the number and density of the species is greater in the halla mýri than in the fórmýri, especially in the dampest areas. The biological spectra agree in regard to the preponderance of the geophytes, while there is an essential difference in the chamaephytes, the Ch percentage being highest in the fórmýri.

In the halla mýri the physiognomical dominant is *Equisetum palustre*, as in the fórmýri it is *Carex Goodenoughii* besides *Erio-*

Table 20 A. **The Mýri Vegetation at Lækjamót.**

Localities 1—5 situated at the foot of Viðidalsfjall on its western side c. 75 m above sea level and represent Halla mýri of various degrees of moisture. 6—7 situated at the bottom of the valley c. 50 m above sea level, Fór mýri. 1, 3, 6, and 7 examined on 21/8 1925; 2, 4, and 5 on 22/8 1925. (25. 1/10 m^2).

			1	2	3	4	5	6	7
Carex panicea	E 3	G	**84**	8	8	»	»	16	
Scirpus caespitosus......	E 4	H	**76**	4	4	12	»	8	
Carex microglochin......	A 2	G	**80**	20	32	36	»	»	»
— capillaris.........	A 3	H	**84**	**96**	20	»	»	12	»
Tofieldia palustris.......	A 2	H	**56**	24	»	»	»	8	
Pingvicula vulgaris......	E 4	H	44	32	»	»	»	8	
Equisetum variegatum...	A 3	H	»	48	12	»	4	»	»
— palustre.....	E 2	G	**60**	**96**	**64**	**88**	**84**	»	
Luzula multiflora.......	E 3	H	16	**60**	8	»	»	16	»
Bartschia alpina........	A 2	H	24	48	»	»	»	»	»
Calamagrostis neglecta...	E 4	H	»	16	12	»	**52**	4	
Trigochin palustre......	E 4	H	»	»	20	40	**64**	»	»
Menyanthes trifoliata....	E 4	HH	»	»	48	48	4	»	
Juncus alpinus..........	E 3	H	4	»	4	**52**	36	»	»
Eriophorum Scheuchzeri.	A 3	HH	»	»	»	»	**56**	»	»
Carex Lyngbyei.........	E 3	G	»	»	»	»	**100**	»	
Eriophorum polystachyum	E 4	G	**96**	16	24	32	40	**96**	**100**
Polygonum viviparum...	A 3	G	**100**	**100**	**88**	**52**	»	**76**	»
Thalictrum alpinum.....	A 2	H	40	**84**	44	»	»	**60**	»
Carex Goodenoughii.....	E 3	G	**72**	**92**	**96**	**100**	**56**	**76**	»
— rariflora..........	A 2	G	40	**96**	**100**	**100**	**60**	**68**	»
— chordorrhiza......	A 1	G	12	»	**68**	20	»	8	**100**
— dioica............	E 4	G	»	»	»	»	»	**84**	»
— saxatilis..........	A 3	G	16	»	4	»	»	**68**	4
Vaccinium uliginosum...	E 4	Ch	**92**	**80**	**68**	4	»	**96**	»
Betula nana............	A 2	Ch	»	»	4	»	»	**68**	»
Agrostis alba...........	E 3	H	»	4	4	»	»	»	»
— canina.........	E 3	H	»	»	4	»	»	»	»
Anthoxanthum odoratum.	E 3	H	»	»	»	»	»	8	»
Cardamine pratensis.....	E 4	H	4	»	»	»	»	12	»
Carex rigida...........	A 3	G	»	16	»	»	»	8	»
— rostrata..........	E 3	HH	»	»	12	»	»	»	»
Cerastium caespitosum..	E 3	Ch	»	32	»	»	»	»	
Deschampsia caespitosa..	E 2	H	»	4	»	»	»	»	»
Dryas octopetala........	A 3	Ch	»	12	»	»	»	»	»
Elyna Bellardi..........	A 3	H	»	»	»	»	»	4	»
Empetrum nigrum......	E 4	Ch	4	4	»	»	»	32	»

TABLE 20A CONTINUED.

			1	2	3	4	5	6	7
Euphrasia latifolia	A 2	Th	4	36	4	4			
Festuca ovina	E 4	H	4	12	4			24	
— rubra	E 4	H		48			4	32	
Galium Normanni	A 1	H		12	4	»		»	»
Gentiana amarella	E 2	H	8	»				»	
Juncus arcticus	A 2	G		4		»			
— trifidus	A 2	H		»		»	»	4	
— triglumis	A 3	H	4	4	8	12	12	»	
Luzula spicata	A 2	H	4	»				»	
Parnassia palustris	E 2	H	»	20			»		
Poa glauca	A 3	H	»	4		»			
Rhinanthus minor	E 2	Th	4	4			»		
Salix glauca	A 3	Ch	4	12					
— herbacea	A 3	Ch	»	4	4			8	»
Silene acaulis	A 3	Ch		4		»		»	»
Thymus serpyllum	E 4	Ch		4		»			

TABLE 20B.

Biological Spectra of the Mýri Vegetation at Lækjamót.

	1	2	3	4	5	6	7
Points sum	1048	1180	780	600	572	908	204
Number of species	29	37	29	14	13	27	3
Density of species	10.5	11.8	7.8	6.0	5.7	9.1	2.0
A	**45.4**	**54.6**	**51.3**	37.3	23.1	43.6	51.0
E	**54.2**	**45.4**	**48.7**	**62.7**	**76.9**	56.4	49.0
A 3	19.8	25.4	17.4	10.7	12.6	19.4	2.0
A 2	23.7	26.4	23.6	23.3	10.5	22.9	»
A 1	1.9	2.7	10.3	3.3	»	1.3	**49.0**
E 4	30.5	18.3	23.1	22.6	28.7	43.6	**49.0**
E 3	16.8	16.6	17.4	**25.4**	**33.6**	12.8	»
E 2	6.9	10.5	8.2	**14.7**	**14.7**		
E 1							
Ch	10.3	14.6	10.8	0.7	»	22.9	
H	**35.1**	**44.6**	19.0	19.3	30.1	22.0	»
G	**53.8**	**38.0**	**62.1**	**71.3**	**59.4**	**55.1**	**100.0**
HH	»	»	7.7	8.0	10.5	»	
Th	0.8	3.4	0.5	0.7	»	»	»

phorum polystachyum, and in the fétmýri *Carex Lyngbyei*. Of other plants it is mostly Cyperaceæ which are found intermixed with *Equisetum palustre*, thus species like *Eriophorum polystachyum*, *Carex Goodenoughii*, *C. rariflora*, *C. microglochin*, *C. capillaris*, *C. panicea*, and *C. chordorrhiza*, besides *Scirpus cæspitosus*. Other more conspicuous plants are *Polygonum viviparum*, *Thalictrum alpinum*, *Luzula multiflora*, *Bartschia alpina*, *Tofieldia palustris*, *Pinguicula vulgaris*, *Selaginella selaginoides*, and *Equisetum variegatum*; of Ch only *Vaccinium uliginosum* occurs with any noticeably high F.-percentage.

Locality No. 2 represents the typical, i. e. the most widespread halla mýri formation; No. 1 is from a somewhat high level, Nos. 4—5 from rather damp soil. If the water in the depression is stagnant, *Carex rariflora* will be the physiognomical dominant (cf. No. 4), if it contains running water, *Carex Lyngbyei* will dominate, perhaps in company with *Eriophorum Scheuchzeri* (cf. Nr. 5). The two formations can be recognised, even at a distance, by their colours, the *Carex rariflora* formation by a darkgreen hue, the *Carex Lyngbyei* formation by its yellowish green tinge. The surface differs from the typical formation by being devoid of knolls.

Where springs are formed in the halla mýri, a moss vegetation will develop. On this vegetation, the dý, Helgi Jónsson writes as follows (1900, p. 25): — "the moss pools occur most frequently at the foot of the mountains where the numerous springs appear; here they pass imperceptibly into the mýri." "The mosses which seem to predominate are *Philonotis fontana* and *Mniobryum albicans* v. *glacialis*." "Scattered here and there in the moss carpet there occur *Epilobium alsinefolium*, *E. Hornemanni*, *Cerastium trigynum*, *Montia rivularis*, *Saxifraga rivularis*, *Ranunculus hyperboreus*, and *Catabrosa aquatica*. In addition there occur *Epilobium palustre*, *E. lactiflorum*, *Eriophorum Scheuchzeri*, *Carex cryptocarpa*, *C. canescens*, *Eriophorum angustifolium*, *Equisetum palustre*, *Carex rariflora*, *Menyanthes* and *Saxifraga stellaris*.

The mosses are exclusively dominant; the intermixed species are both few and far between."

The fórmýri is only found at the bottom of the valley. An essentiel difference between halla mýri and fórmýri is this that *Equisetum palustre* is lacking in the fórmýri, *Betula nana* in the halla mýri. The most conspicuous plants are *Eriophorum polystachyum*, *Vaccinium uliginosum*, and *Betula nana*, further *Carex Goodenoughii*, *rariflora*, *saxatilis*, and *dioica*, besides *Polygonum viviparum* and

Thalictrum alpinum. Of minor importance are *Festuca ovina, F. rubra, Cardamine pratensis,* and *Empetrum nigrum.*

Where the ground-water covers the soil throughout the year the knolls disappear, the surface is level, and the flói vegetation is formed (cf. table 20,7). The dominant species are *Eriophorum polystachyum* and *Carex chordorrhiza.*

D. NORÐTUNGA.

In the preceding part we have dealt with all the lowland types of vegetation except the forest. In the following I shall give a description of it in so far as I was able to examine it during a couple of days' stay on the farm Norðtunga in Borgarfjörður.

Here the forest occurs both at the bottom of the valley and on the sunny northern slope, but not on the shady southern slope. The succeeding investigations, however, apply especially to the forest at the bottom of the valley.

Viewed from one of the valley slopes the forest does not appear as a continuous growth in the sense that the trees are equally distributed over the entire area of growth, but open patches where the birch is low, very scattered, or entirely absent, alternate with stretches where the growth is denser. It was, however, especially on the outskirts that this was the case, in the interior of the forest the growth was continuous.

Fig. 14 shows a glade in the forest. The soil is full of large knolls.

The statistical results are given in table 21 A. Nos. 1—2 are from the forest itself, 3—6 from the glades in the forest, No. 7, finally, is the mo some distance outside the forest between the latter and the farm.

On the forest-ground proper grasses are dominant, the following being the most numerous: *Deschampsia flexuosa, Anthoxanthum odoratum, Agrostis canina* and *A. tenuis,* further *Festuca rubra;* of herbaceous plants there occur *Thalictrum alpinum, Carex rigida, Galium boreale* and *Normanni,* and *Polygonum viviparum.* The chamaephytes are of minor importance, *Vaccinium uliginosum* and *Empetrum nigrum* are found here and there.

The vegetation of the glades occupies an intermediate position between the forest-ground and the mo. The species known from the forest-ground recur here, moreover a number of typical

Table 21 a. **The Forest Undergrowth at Norðtunga.**

Localities 1—2 represent forest undergrowth below dense birch copses, 3—6 the vegetation in open birch copses or glades; 7 is the mo vegetation outside the forest. 1, 4 and 6 examined on 25/8 1725, 3 on 26/8, 2, 5 and 7 on 27/8 1925. (25. 1/10 m²).

			1	2	3	4	5	6	7
Betula pubescens	E 3	F	**100**	**100**	**88**	24	4	4	
Deschampsia flexuosa....	E 3	H	**96**	**100**	**80**	**76**	**80**	**84**	16
Anthoxanthum odoratum	E 3	H	**68**	48	48	**68**	**64**	**92**	4
Agrostis canina	E 3	H	**60**	**60**	44	**96**	**60**	**88**	**92**
Festuca rubra	E 4	H	**52**	44	**76**	**76**	**92**	**88**	**96**
Thalictrum alpinum	A 2	H	**60**	**60**	**60**	**80**	**76**	**96**	**80**
Carex rigida	A 3	G	44	**76**	**60**	**80**	**64**	**76**	**72**
Galium boreale	E 2	H	32	48	**80**	**72**	**68**	**92**	**72**
— Normanni	A 1	H	36	4	32	**64**	**60**	**56**	**68**
Polygonum viviparum ...	A 3	G	36	12	44	**64**	**60**	**76**	**76**
Vaccinium uliginosum ...	E 4	Ch	36	24	**88**	**92**	**84**	**76**	**88**
Empetrum nigrum	E 4	Ch	24	8	**56**	**76**	**72**	**84**	**84**
Juncus trifidus..........	A 2	H	8	4	20	40	28	20	**60**
Festuca ovina...........	E 4	H	4	16	20	**52**	48	32	**64**
Galium verum	E 1	H	8	8	44	**56**	**56**	36	»
Luzula multiflora	E 3	H	8	8	48	36	24	20	12
Elyna Bellardi	A 3	H	»	»	4	32	16	8	**84**
Thymus serpyllum	E 4	Ch	»	»	12	4	20	»	**88**
Salix herbacea	A 3	Ch	»	»	»	12	8	8	**64**
Equisetum pratense	E 2	G	»	36	4	»	32		**52**
Luzula spicata	A 2	H	»	»	4	4	»	»	48
Selaginella selaginoides ..	A 1	Ch	»	»	4	12	»	4	40
Silene acaulis	A 3	Ch	»	»	»	»	»	»	32
Agrostis tenuis..........	E 2	H	»	36	**64**	»	12	»	12
Armeria vulgaris	A 3	Ch	»	»	»	»	»	»	4
Botrychium Lunaria.....	E 4	G	»	»	»	»	»	4	
Cardamine pratensis.....	E 4	H	»	28	»	8	12	8	
Cerastium alpinum	A 3	Ch	4	»	»	»	»	»	4
— caespitosum ..	E 3	Ch	4	4	»	»	»	»	
Equisetum arvense	E 4	G	»	»	»	8	»	4	16
— variegatum...	A 3	H	»	»	4	»	»	»	
Erigeron neglectus	A 1	H	»	»	»	8	»	»	4
Euphrasia latifolia	A 2	Th	»	»	»	»	»	»	4
Geranium silvaticum	E 3	H	»	»	20	»	»	»	»
Hieracium silvaticum....	E 2	H	»	»	4	»	»	»	
Hierochloë odorata	E 2	G	»	»	»	»	»	4	
Leontodon autumnalis...	E 3	H	»	4	32	4	4	20	
Pingvicula vulgaris	E 4	H	»	»	4	4	»	»	24

TABLE 21 A CONTINUED.

			1	2	3	4	5	6	7
Poa alpina	A 2	H	4	»	»	»	»		
— glauca	A 3	H	12	8	»				
— pratensis	E 4	G	»	12	»	»	»	12	
Potentilla verna	A 2	H	»	»	»	8	4	»	12
Ranunculus acer	E 4	H	»	8	»	»	»		
Rubus saxatilis	E 3	H	»	»	4	»			
Rumex acetosa	E 3	H	8	8	4	»	»	»	4
Taraxacum officinale	E 2	H	»	4	12	»	8	12	
Trisetum spicatum	A 3	H	»	»	»	16	4	4	16
Viola palustris	E 3	H	»	4	8	»	8	16	

TABLE 21 B. **Biological Spectra of 21 A.**

	1	2	3	4	5	6	7
Points sum	704 (604)	772 (672)	1072 (984)	1172 (1148)	1068 (1064)	1124 (1120)	1392
Number of species	20	26	30	27	26	27	31
Density of species	6.0	6.7	9.8	11.5	10.6	11.2	13.9
A	29.0	21.2	21.6	35.8	30.0	31.0	**48.0**
E	**71.0**	**78.8**	**78.4**	**64.2**	**70.0**	**69.0**	**52.0**
A 3	13.6	12.4	10.4	17.4	14.2	15.3	**25.3**
A 2	10.2	8.3	7.8	11.3	10.1	10.3	14.7
A 1	5.1	0.5	3.4	7.2	5.6	5.3	8.0
E 4	16.5	18.1	23.9	27.3	30.7	27.4	33.0
E 3	48.9	43.5	35.1	25.9	22.8	28.8	9.2
E 2	4.5	16.1	15.3	6.1	11.2	9.6	9.8
E 1	1.1	1.0	4.1	4.8	5.2	3.2	»
Ch*	11.3	5.4	16.3	17.1	17.3	15.4	**29.0**
H	**75.5**	**74.4**	**72.8**	**69.7**	**68.0**	**68.9**	**55.2**
G	13.2	20.2	11.0	13.2	14.7	15.7	15.5
HH	»	»	»	»	»	»	
Th	»	»	»	»	»	»	0.3

mo plants begin to appear, though only here and there. Grasses still dominate, thus *Deschampsia flexuosa*, *Anthoxanthum odoratum*, *Agrostis canina*, *Festuca rubra* and *ovina*, *Luzula multiflora*, *Juncus*

trifidus, and *Carex rigida*; some herbaceous plants likewise occur, thus *Polygonum viviparum, Thalictrum alpinum, Galium boreale, Normanni,* and *verum.* The chamaephytes *Vaccinium uliginosum* and *Empetrum nigrum* occur with as high an F.-percentage in the mo.

The mo is the typical Icelandic mo, with the same species that occur elsewhere; selected at random the most conspicuous plants are: *Agrostis canina, Festuca rubra* and *ovina, Carex rigida, Polygonum viviparum, Thalictrum alpinum, Galium boreale* and *Normanni, Vaccinium uliginosum, Empetrum nigrum, Juncus trifidus, Luzula spicata, Selaginella selaginoides, Elyna Bellardi, Thymus serpyllum, Salix herbacea, Trisetum spicatum,* and *Silene acaulis.*

The following essential difference between the mo and the forest-ground vegetation may be noted. The mo vegetation is characterised by Ch and A species, the forest-ground vegetation by H, especially grasses, and E species. These differences will no doubt prove greater upon closer investigation. The forest-ground at Norðtunga was non-typical in so far as a series of typical forest-ground plants such as *Fragaria vesca, Rubus saxatilis, Geum rivale, Brunella vulgaris, Trifolium repens, Geranium silvaticum, Vaccinium myrtillus, Arctostaphylos uva ursi, Calluna vulgaris* and several others did not occur here.

V. THE ICELANDIC HIGHLAND FORMATIONS.

No thorough investigations of the highland vegetation which might serve as a basis for comparison with the lowland vegetation and the vegetation in other localities in the highlands having so far been carried out, I have endeavoured to furnish such a basis by my investigations. By its geographical position, its height above sea level, and the grandeur of its scenery, Tvídägra, the highland plateau west of Langjökull, seemed to me best fitted for such a purpose. Hence the investigations described below have been carried out there, that is, more precisely indicated, in the region round Úlfsvatn on Arnarvatnsheiði.

Before I proceed to a more detailed description of my own investigations I shall give an account of what is known about the highland vegetation. The first more comprehensive description is that of St. Stefánsson (1894). On p. 199 Stefánsson writes: "At the Vatnsdalshals and on the high plateau we especially meet with three formations, viz. the mýri, melar and heather mo vegetations." The latter I found best developed in the so-called "Helgavatnsnupar", gravelly heights on the eastern margin of the Vatnsdalshals. The depressions between these are more or less, and sometimes entirely, covered with a greenish-brown carpet formed of *Empetrum nigrum*, *Vaccinium uliginosum*, and *Betula nana* completely mixed up with each other. *Salix herbacea* and *glauca* also occur almost everywhere throughout this carpet, whereas *Salix lanata* appears only here and there. *Loiseleuria procumbens* is found in no small quantity in several places, and *Cassiope hypnoides* is met with here and there. In several places the dwarf birch predominates over the crowberry *(Empetrum nigrum)*, but as a rule the latter is dominant. Of other plants I shall mention first *Dryas octopetala*, which is hardly ever absent from any Icelandic heather mo, next *Thymus serpyllum*, *Polygonum viviparum*, *Galium silvestre*, *Silene*

acaulis, *Armeria* (here and there), *Cerastium alpinum*, *Tofieldia borealis*, *Juncus trifidus*, *Luzula spicata* and *L. multiflora*, *Alchemilla alpina*, *Pingvicula vulgaris*, *Carex rigida*, *Festuca rubra*, and further, where the soil is a little damp, *Saxifraga Hirculus*, and *Sedum villosum*".

On the high plateau to the south of Vatnsdalur the heather mo is "stunted and patchy" and "the gravelly subsoil comes to the surface everywhere." The composition of the species is as follows: *Empetrum*, *Betula nana*, *Salix glauca*, (here and there), *Salix herbacea*, a very scattered growth of *Vaccinium uliginosum*, *Dryas octopetala*, (rather sparingly), *Elyna Bellardi*, *Silene acaulis*, *Armeria maritima*, *Cerastium alpinum*, *Polygonum viviparum*, *Trisetum spicatum*, *Poa caesia*, *Festuca ovina v. vivipara*, *Thalictrum alpinum*, and *Arabis petræa*.

The melar vegetation on Vatnsdalshals is described as follows; "*Silene acaulis* and in some places *Dryas* are the most conspicuous plants, notably in the flowering season but, in addition to these and several other plants growing among the heather, there also occur *Silene maritima*, *Saxifraga oppositifolia*, *S. decipiens*, *S. nivalis*, and on high, almost quite bare, gravelly flats *Arenaria ciliata*, *Alsine verna*, *f. propinqua*, *Arabis petræa f. glabra* and *hispida*, *Draba verna*, *Trisetum subspicatum*, *Rumex acetosella*, *Armeria maritima* and others."

In the highlands south of the valley the melar vegetation "resembles that of Vatnsdalshals, but is much poorer in species."

On Vatnsdalsfjall, "on the gravelly crest of the mountain, c. 2000′ above the sea, the typical mountain field or melar vegetation, where the plants occur in isolated specimens with large bare patches between, attains its full development, almost without the invasion of any foreign elements. I observed the following species: *Ranunculus glacialis*, *Luzula arcuata*, (both characteristic of high mountains), *Luzula spicata*, *Poa pratensis*, *P. alpina (vivipar)*, *P. caesia*, *Aira alpina*, *Saxifraga nivalis*, *S. oppositifolia*, *S. hypnoides*, *Cerastium alpinum*, *Erigeron alpinus*, *Polygonum viviparum*, *Silene acaulis*, *Dryas octopetala* (in small quantity), *Potentilla maculata*, *Ranunculus acer*, *Armeria sibirica*, *Salix herbacea*, *Trisetum subspicatum*."

On Víðidalsfjall, at a height of c. 3000′ the melar vegetation had the following composition: *Silene acaulis*, *Saxifraga oppositifolia*, *Sedum acre*, *Ranunculus glacialis*, further *Cerastium alpinum f. lanata*, *Poa alpina*, *Aira alpina*, *Poa caesia*, *Saxifraga hypnoides*, *S. decipiens*,

Polygonum viviparum, Silene acaulis, Armeria maritima, Salix herbacea, Arabis petræa, A. alpina, Saxifraga cernua and *S. nivalis.*

The third type of vegetation mentioned by Stefánsson is the mýri vegetation. This is described as follows in pp. 201—203. "On Grimstungnaheiði to the south-west of Vatnsdalur I met with a rather widespread form of vegetation which somewhat resembled the usual heather mo by its uneven, more or less knolly surface and its greyish hue, but the soil is rather damp, at least in the early summer, and here *Grimmia hypnoides* is entirely dominant, covering large areas completely." These moss moes "which must in the main be regarded as transitional between the heather mo and the extensive vegetation of the pools" are poor in flowering plants, though *Cassiope hypnoides* and *Pedicularis flammea* are of common occurrence.

On the vegetation proper of the pools Stefánsson writes: "even at a distance two variations of this vegetation may easily be distinguished, the brownish Eriophorum pools characterised by *Eriophorum angustifolium* and the bluish-green Carex pools, where the bluish or greyish-green *C. ampullacea* is the dominant plant. This difference is so striking that the peasants have a special term for each of these: the former, the Eriophorum pools, are called "Brokflá", while the latter pools are called "Ljosastarar flá". They also differ somewhat with regard to composition of species. In the Eriophorum pools *Carex pulla, C. alpina, C. vulgaris,* and *C. hyperborea* are the most conspicuous, whereas, in the Carex pools, *Carex rariflora, C. vaginata,* and *C. vulgaris* are very common, likewise *Juncus biglumis.* But as a whole this vegetation of the highland pools is extremely poor in species, and of dicotyledons I only observed very few" e. g. *Cardamine pratensis* and *Stellaria crassifolia.*

"Below, on Vatnsdalshals the vegetation of the pools is somewhat richer and more like that of the pools at the bottom of the valley, though not nearly so luxuriant. It consists in the main of the common sedges, e. g. *Carex vulgaris, C. chordorrhiza, C. rariflora* and *C. rigida, Eriophorum polystachyum,* and *Scirpus cæspitosus.*"

These are the three types of vegetation, mo, melar, and mýri, occurring in the highland tracts around Vatnsdalur. However, from the descriptions we must assume that, in addition to these three, there occurs a fourth type viz. the geiri or snow patch vegetation. Thus Stefánsson, when dealing with the vegetation on Viðidalsfjall, on p. 196, writes as follows: "Some of the little grooves

extending like green or brownish-green bands down the greyish slopes were, where the soil was damp, overgrown with grass and cyperaceous plants, others, on the other hand, had a dwarfish heath vegetation where as usual *Empetrum* was dominant in company with *Vaccinium uliginosum* and *Salix herbacea*. In the greater depressions this heath vegetation was very abundant. In such a depression I observed: *Empetrum*, *Vaccinium uliginosum* and *Myrtillus*, *Salix herbacea* and *glauca*, *Anthoxanthum odoratum*, *Leontodon autumnalis*, *Phleum alpinum*, *Rumex acetosa*, *Coeloglossum viride*, *Aira flexuosa* and several others."

"On small flat, sometimes almost horizontal, ledges far up the mountain, c. 1500—2000′ above the sea, but notably in the cup-shaped depressions and smaller round valleys where the snow remains until far into the early summer, and a layer of humus has gradually formed on the rocky bottom, the dwarf willow becomes entirely dominant. This small very hardy dwarfish growth in such localities forms a dense "half-inch wood" which covers large areas of the barren rocky ground like oases." Of flowering plants I noted the following in a large area of dwarf willows: *Salix glauca* (few and small specimens), *Poa alpina*, *Aira alpina*, *Thalictrum alpinum*, *Cerastium alpinum*, *Thymus serpyllum*, *Erigeron alpinus*, *Luzula spicata*, *L. arcuata*, *Galium silvestre*, *Oxyria digyna*, *Armeria maritima*, *Phleum alpinum*, *Polygonum viviparum*, *Festuca rubra*, *Ranunculus acer*, *Gnaphalium supinum*, *Rumex acetosa*, *Carex lagopina*, *C. rigida*. Further *Alchemilla vulgaris* and *Sibbaldia* were intermixed with the dwarf willow covering, but these plants also formed dense growths on damp spots rich in humus. The common heath plants *Dryas*, *Empetrum*, and *Juncus trifidus* occurred in very small quantity. But this composition of the species varies somewhat according to the varying degree of moisture of the soil. Thus, on a cold and damp slope with a north-eastern exposure, where the turf was chiefly formed of *Salix herbacea*, in addition to many of the abovementioned plants I noted the following: *Cerastium trigynum*, *Ranunculus pygmæus* (in several places these two latter species are found as associates), *Saxifraga stellaris*, *Veronica alpina*, *Epilobium alpinum*, all in quantity; further *Taraxacum officinale*, *Equisetum variegatum*, and *Alchemilla alpina*."

On pp. 194—195: "the three latter (*Gnaphalium norvegicum*, *G. supinum*, and *Sibbaldia procumbens*) occurred here and there in small depressions and grooves in such quantity that they formed

a continuous carpet." The three species referred to are some of the most typical plants of the snow patches in Iceland.

The above-cited descriptions of localities in connection with the flora lists given correspond closely to the geiri vegetation elsewhere, e. g. on Lýngdalsheiði and Arnarvatnsheiði, and even though Stefánsson does not distinguish the geiri or snow patch vegetation as a separate type, its presence in the highland tracts around Vatnsdalur may be taken for granted. Hence the vegetation here consists of the following four types: melar, mo, mýri, and geiri.

The highland vegetation of East Iceland and Snæfellsnes has been described in more detail by Helgi Jónsson. In "Vegetationen paa Snæfellsnes", where the highland vegetation is dealt with, Helgi Jónsson distinguishes between 3 types, viz. grimmia heath, mountain pools, and fell-field ("Fjeldmark").

Of the **fell-field** we find the following statement on p. 27 ff.: "the fell-field, as taken here, extends over the upper region of the mountain from the upper limit of the heather moor at c. 300—400 m. above the sea, to the snow line, with the exception of the mountain pools and the grimmia heath." "Its surface is very heterogeneous, consisting now of extensive gravelly or gravelly and clayey flats, now of more or less downward sloping stretches, bare rocks and screes. In smaller hollows the subsoil is covered with layers of clay, and in depressions lakes of greatly varying sizes are met with."

"The plants of the fell field are scattered here and there, either in solitary specimens at a considerable distance from each other, or they are collected in small scattered tufts. Often they occur in patches, forming a carpet, notably the mosses, *Salix herbacea* and *Sibbaldia*. The scattered plants and the scattered patches of growth do not, however, affect the physiognomy of the landscape. What characterises the fell field is principally the stony, gravelly, or clayey soil."

"The vegetation of the fell field is very heterogeneous since, as was pointed out, the soil is very varied. As regards the appearance of the vegetation, the factors of decisive importance, besides the height above the sea, are the greater or less exposure of the locality and its water supply."

"The part played by the phanerogams in the composition of the vegetation grows less and less with increasing height; at the lower limit of the fell field on the other hand, they are very abundant. Here small *Empetreta* are met with in patches, *Loiseleurieta*, *Cassi-*

opeta, *Saliceta (herbacea)* and *Sibbaldieta* in irregular and confusing intermixture. Interspersed among them there are many herbs which do not belong to the fell field, especially the herbs of the heather moor. There is no well-marked limit here, but the fell field may be plainly distinguished by the fact that the plants of the heather moor are not able to form any heath but grow in patches or as scattered specimens, and that the small characteristic *Saliceta (herbacea)* and *Sibbaldieta* of the fell field have begun to appear."

H. Jónsson distinguishes between the following 5 types of vegetation in the fell field: gravelly flats, screes, the Anthelia-crust, the Salix herbacea and Sibbaldia vegetation, and the Philonotis fontana dý.

I. The gravelly flats. "With the exception of the naked rocks, the gravelly flats are those parts of the fell-field which are poorest in vegetation. In the upper part of the fell-field they are exceedingly poor in plants, especially if they are exposed; in the lower part of the exposed flats often only a solitary *Ranunculus glacialis* or a solitary *Cerastium alpinum* is met with. On less exposed flats in the lower part of the fell-field a considerably richer vegetation is met with." In such a locality *Salix herbacea* and *Alchemilla alpina* occurred in patches, further *Armeria*, *Aira alpina*, *Luzula spicata*, *Oxyria digyna*, *Cerastium alpinum*, *Silene acaulis*, *Arabis petræa*, *Galium silvestre*, and *Saxifraga cæspitosa*.

"On the gravelly flats which are studded with small shelter-givers, small stones dispersed more or less closely over the flat, we meet with the richest vegetation which can occur on a gravelly flat in the fell-field. Round the little stones there occur narrow fringes of *Grimmia hypnoides*. In the Grimmia fringes grow the most frequently occurring plants of the fell-field.

II. The screes. "From the last-mentioned gravelly flats there occur the smoothest transitions to the screes. When the shelter-givers, the scattered stones, become larger and occur closer together, the surface loses the character of a gravelly flat and must be regarded as a scree with small stones. Here *Grimmia hypnoides* is the most important plant, though it does not form heath." "As regards the plants intermixed with it, we must distinguish between the upper and the lower fell-field, or levels above and below 600 m."

In the upper fell field there is as a rule only an intermixture of lichens, the phanerogams are poorly represented. "Thus, in the upper part of the fell-field on Snæfellsnes Jökull at an altitude of 600 m. only the following species were met with: *Armeria maritima*,

Silene acaulis, *Luzula arcuata*, *Arabis petræa*, *Aira alpina*, *Oxyria digyna*, *Salix herbacea*, and *Saxifraga rivularis*." "At higher levels only some few individuals of *Salix herbacea*, *Sibbaldia procumbens*, and *Aira alpina* were met with."

"In the lower fell-field the phanerogams play a much more prominent part". The most frequent plants here are: *Salix herbacea*, *Saxifraga rivularis*, *Sibbaldia procumbens*, *Oxyria digyna*, *Ranunculus glacialis*, *Pedicularis flammea*, *Luzula arcuata*, and *Epilobium anagallidifolium*.

"The following occur frequently: *Silene acaulis*, *Carex rigida*, *Polygonum viviparum*, *Empetrum nigrum*, *Loiseleuria procumbens*, *Cassiope hypnoides*, *Armeria maritima*, *Arabis petræa*, *Veronica alpina*, *Thalictrum alpinum*, *Luzula spicata*, *Juncus trifidus*, *Saxifraga cæspitosa*, *Alchemilla alpina*, *Cerastium alpinum*, *Aira alpina*, *Thymus Serpyllum*, *Saxifraga oppositifolia*, *Gnaphalium supinum*, *Cerastium trigynum*, *Poa glauca*."

"The less frequent are: *Betula nana*, *Dryas octopetala*, *Papaver radicatum*, *Salix glauca*, *Trisetum subspicatum*, *Poa alpina*, *Pyrola minor*, *Saxifraga nivalis*, *S. hypnoides*, *Galium silvestre*, *Ranunculus acer*, *Cystopteris fragilis*. Of rarer occurrence are: *Taraxacum lævigatum*, *Rumex acetosa*, *Rhodiola rosea*, *Carex lagopina*, *Potentilla verna*, *Luzula multiflora*, *Festuca ovina*."

III. The Anthelia crust. "On gravelly, clayey, or stony soil, in the mountains, at an altitude of 300—700 m., increasing with the height, a grey crust, dispersed in patches, is very often met with. It is formed exclusively of *Anthelia nivalis*. Interspersed with it I sometimes found *Grimmia hypnoides*, *G. ericoides* and *Salix herbacea*. This *Anthelietum* often borders on the *Salix herbacea* depressions. Transitional forms between the Anthelia and the Salix herbacea vegetation are occasionally found."

IV. The Salix herbacea and Sibbaldia vegetation. ". . . occupies the aforementioned depressions where the clayey strata cover the subsoil. The main dispersal of this vegetation lies between 300 and 600 m. above sea level. In the lower part there is often a strong admixture of the elements of the heather moor, and at an altitude of over 600 m. it passes into the moss vegetation. An undergrowth formed of mosses is nearly always present." "Very often it is formed of *Grimmia hypnoides* and occasionally of *Anthelia nivalis*." "Not a few of the phanerogams of the fell-field are interspersed in the Salix and Sibbaldia patches. As far as I could

see, the following species were exclusively associated with this vegetation: *Taraxacum laevigatum*, *Epilobium anagallidifolium*, *Carex lagopina*, *Gnaphalium supinum*, *Pirola minor*." "Of the two dominant species, *Salix herbacea* and *Sibbaldia procumbens*, *Salix herbacea* is found in the greatest proportion. They either occur as separate dominants, or they dominate together intermixed with one another, and then either in equal number or with preponderance of the one or the other."

V. The Philonotis fontana Dý. "On damp gravel and at small springs small cushions of *Philonotis fontana* occur. In these light-green cushions of moss some flowering plant is generally met with, *Cerastium trigynum* and *Saxifraga rivularis* especially show a predilection for these spots. These moss cushions correspond to the dý occurring at lower levels."

The second type of vegetation which H. Jónsson distinguishes is that of **rock pools.** 1900, p. 20 he writes: "Up the mountains, though not at very high levels, there occurs a characteristic vegetation met with near pools, the vegetation of the rock pools; these pools are especially *Eriophorum* pools where *E. angustifolium* is solely predominant. They are extremely poor in species, yet we may mention the occurrence of scattered *Carex rostrata*, *C. pulla*, and *C. alpina*."

The third type of vegetation is the **Grimmia heath.** We have previously dealt with this vegetation (p. 40) with the main result that it belonged to the higher regions of the country to the south and east of the jökull line. It was most abundantly developed in the foggy and rainy regions of East Iceland, decreasing to the westward, and being absent in the north. "In the lowlands and at the lower levels of the mountains it changes in time and gives place to other plant societies; as a rule many phanerogams and vascular cryptogams are intermixed with it. These decrease considerably with increasing height above the sea, and have almost entirely disappeared from the Grimmia heath of the highest levels (at c. 600—700 m.); there only solitary, very widely scattered, common fell-field plants are met with."

A comparison shows a great, but probably more apparent than real, difference between the vegetation schemata of the two authors. Stefánsson describes the following types: melar, mo, mýri, and snow-patch, Helgi Jónsson: fell-field (with sub-divisions gravelly flats, screes, the Anthelia crust, the Salix herbacea and Sibbaldia

vegetation, and the Philonotis dý), rock pools and Grimmia heath. Since the Grimmia heath does not occur in North Iceland, this type may be left out of consideration, and of the remainder only the mýri and the rocky pools are identical. Judging from the description, H. Jónsson's fell-field comprises Stefánsson's melar, mo, and snow-patch, gravelly flats and screes corresponding to melar and mo, while the Anthelia crust and the Salix herbacea and Sibbaldia vegetation must be regarded as snow patch vegetations. Thus for the highlands we get the following vegetation scheme which, in its main lines, is the same as on Lýngdalsheiði, viz. 1) melar (and, in addition, for South and East Iceland, Grimmia heath), 2) mo, 3) mýri (including dý), and snow-patch (including the Salix herbacea and Sibbaldia vegetation and the Anthelia crust). In the following each of these types will be dealt with in more detail.

As previously mentioned, the investigations to be described in the following were carried out on Arnarvatnsheiði. The latter forms part of the large plateau north-west of Langjökull which divides the Húna Flói area of valleys in the north from the Borgarfjörður area of valleys to the south. The surface of the plateau consists of deposits of the glacial period and appears as a landscape with countless downs, depressions, and lakes.

Of more conspicuous types of vegetation we find: melar, Betula nana mo, the knolly mo, jaðar, mýri and flói, and geiri. The melar vegetation attains development at the top and on the ridges of the downs, occasionally some distance down the slopes. The Betula nana mo (or the level mo) occurs on large flats at high levels among tracts of melar. The mo (the knolly mo) occurs in small hollows in the Betula nana mo, along the slopes of the downs, in large flat depressions at high levels, and in the margins of the snow patches. Jaðar occurs especially in the depressions between the downs and on the borders of the mýrar, while the mýri vegetation occurs in the larger and deeper depressions and around the lakes. The moister parts of the mýri are occupied by the flói. The geiri vegetation attains its finest development in large shovel-formed depressions in the hills, most frequently, though not so typically, developed along the slopes of the hills.

As elsewhere in Iceland, the melar and geiri vegetations are dependent respectively on a slight and a deep snow-covering. The

series: mo, jaðar, mýri, and flói depends on the increasing content of moisture in the soil. In the following I shall describe the physiognomic, biological, and floristic relations of the individual types of vegetations.

The Melar Vegetation. Cf. figs. 15—17 and table 22 A, 1—6.

As mentioned above, the melar vegetation occurs at the top and on the ridges of the moraine walls. In the winter, when the landscape is covered with snow, these are either bare or have a very slight snow-covering. Consequently the frost penetrates deeper into the earth which again causes a slower process of thawing in the spring. This in connection with the position causes solifluction from the ridge of the hill towards the depression. On a steep slope the material will pour down in large tongues, as seen in fig. 23; if the slope is less steep, it will arrange itself in small ledges with a naked, gravelly horizontal surface, outwardly bounded by an edge covered with plants which connects the two corners of the ledge like a sweeping garland. Looking towards the depression, such an area of solifluction looks very poor in plants (cf. fig. 16), looking towards the ridge of the hill, the same surface seems somewhat more clothed with plants (cf. fig. 17).

The characteristics of melar are thus a slight or no snow-covering, solifluction, and a bare gravelly or stony soil.

The composition of the melar vegetation has been given in table 22 A, 1—6. Despite the open vegetation a relative abundance and density of species occur. The average number of species is 27, the density c. 8, varying from 5.6 to 9.4. In the biological spectrum the chamaephytes dominate with an average percentage of 52.4, H and especially G are relatively less important. The Th percentage is c. 2. Even if this figure is low, it is comparatively high compared with the Th percentage of the south country, a fact which it seems natural to connect with the relatively continental climate of the highlands. On melar in the north country the Th percentage is still higher: here the climate not only tends to be more continental than in the south country, but is also milder than in the highlands.

The A and E species are as 4 to 1; within the A sub-groups A 3 is especially conspicuous, the average percentage being 55.4. Of the E sub-groups only E 4 occurs and with a somewhat lower percentage than in the other types of vegetation.

Of plants which are characteristic, that is to say, which either occur here exclusively or occur here with the greatest F.-percentage, or which are comparatively frequent on melar, we may mention the following chamaephytes: *Thymus serpyllum, Cerastium alpinum, Arabis petræa, Minuartia verna, Arenaria ciliata, Saxifraga cæspitosa,* and *S. oppositifolia, Dryas octopetala, Empetrum nigrum, Salix herbacea,* and *Silene acaulis.* Of hypogeophytes we mostly meet with grasses and cyperaceous plants. The following species occur: *Poa glauca, Festuca ovina, Juncus trifidus, Luzula arcuata,* and *L. spicata,* further *Polygonum viviparum.* Of species found exclusively on melar and thus characteristic of this type, we may mention *Arabis petræa, Luzula arcuata, Saxifraga cæspitosa* and *S. oppositifolia.* Of therophytes only *Euphrasia latifolia* occurs.

The Betula nana mo. Cf. fig. 18 and table 22 A, 7—11.

This type of vegetation, provisionally named after its dominant chamaephyte, *Betula nana,* and referred to the mo on account of its comparatively close carpet of vegetation, occurs especially in large flat stretches among tracts of melar. The surface is not knolly as in the typical mo, nor does solifluction occur in any appreciable degree, as in melar. In small hollows in the Betula nana mo (the level mo), we meet with the knolly mo, which would seem to indicate a comparatively low degree of moisture in the soil of the Betula nana mo. Its distribution points to a snow-covering intermediate between the two types melar and knolly mo.

The vegetation is continuous, a feature which renders the Betula nana mo physiognomically very different from melar. The number and density of species are, however, not very much higher than in melar, the number of species being 32, the density 11.3, varying from 10.4 to 13.0. In the biological spectrum Ch are still dominant, even though the Ch percentage is reduced from 52 to 47. The reduction of the Ch percentage has resulted in an increase in the G percentage from 9.9 to 15.2. The species group spectrum shows a similar change; the A percentage has been reduced from 81 to 70, the A 3 percentage from 55 to 43, while, on the other hand, the A 2 percentage has risen. The increase of the E percentage falls practically only to E 1, which shows a percentage of 29 against 19 in the melar vegetation. The E 3 group only occurs with a percentage of 0.8.

The difference between melar and the Betula nana mo is most striking in a floristic respect, as even a hasty glance at table 22 A

TABLE 22 A.

The Melar and Betula nana Mo Vegation on Arnarvatnsheiði.

Localities 1—6 represent the melar vegetation, 7—11 the Betula nana mo. All localities situated near Úlfsvatn c. 500 m. above sea level. No. 1 examined on 4/8 1925, 2 and 7 on 5/8, and 8 on 6/8; 4 and 9 on 7/8, 5—6 and 10—11 on 8/8 1925. (25. 1/10 m²).

			1	2	3	4	5	6	7	8	9	10	11
Luzula arcuata..........	A 3	H	12	12	12	16	12	8	»	»	»	»	
Saxifraga caespitosa	A 3	Ch	8	20	4	16	16	16					
— oppositifolia ...	A 3	Ch	8	»	12	4	16	»					
Arabis petræa...........	A 1	Ch	28	32	**60**	12	36	48	»	»			
Euphrasia latifolia	A 2	Th	12	16	4	8	16	4	4	16	4	»	8
Cassiope hypnoides......	A 2	Ch	32	8	»	36	4	»	40	12	32	»	8
Minuartia verna.........	A 3	Ch	40	36	28	12	44	48	4	28	8	12	4
Thymus serpyllum	E 4	Ch	44	**52**	48	24	**52**	**76**	32	»	»	4	4
Poa glauca	A 3	H	48	**60**	44	28	48	44	16	4	4	4	»
— alpina...	A 2	H	8	8	»	»	16	16	8	4	4	12	12
Cerastium alpinum......	A 3	Ch	36	**52**	20	36	**52**	**64**	16	20	»	4	8
Dryas octopetala	A 3	Ch	**52**	32	28	**52**	48	32	**56**	8	12	32	20
Luzula spicata	A 2	H	**80**	**72**	36	**68**	**64**	**92**	48	**64**	40	40	28
Polygonum viviparum ...	A 3	G	**100**	**72**	48	**100**	**68**	**80**	**96**	**100**	**100**	**92**	**100**
Empetrum nigrum	E 4	Ch	**64**	24	12	**64**	4	»	**100**	**80**	**96**	**96**	**92**
Salix herbacea	A 3	Ch	**64**	40	**68**	**76**	**72**	32	**84**	**84**	**84**	**96**	**80**
Silene acaulis	A 3	Ch	**72**	44	44	**80**	**84**	**68**	**60**	**68**	**64**	**60**	44
Juncus trifidus..........	A 2	H	**60**	8	28	**56**	**56**	**52**	**56**	20	**52**	44	28
Festuca ovina	E 4	H	**52**	36	44	**60**	**68**	**80**	20	48	48	**56**	40
— rubra...........	E 4	H	20	24		8	12		**88**	**68**	**84**	**52**	**92**
Thalictrum alpinum.....	A 2	H	4	12		4		8	**60**	**88**	**72**	**88**	**72**
Salix glauca	A 3	Ch	8	16	8		4	12	40	40	**72**	**80**	44
Betula nana	A 2	Ch	»	»	»	»	»	»	48	16	48	48	**64**
Vaccinium uliginosum ...	E 4	Ch	4	8		12			**72**	**60**	**76**	**88**	**92**
Carex rigida	A 3	G	»	»	»	»	»	»	28	**60**	**56**	40	**52**
Elyna Bellardi	A 3	H	4	12	»	8	12	»	32	4	24	**68**	20
Armeria vulgaris	A 3	Ch	8	12	»	20	»	»	32	40	12	4	24
Galium Normanni	A 1	H	4	»	8	4	»	8	32	12	4	32	12
Viscaria alpina..........	A 2	H	12	8	4	4	»	8	8	20	4	20	12
Equisetum arvense	E 4	G	»	»	»	»	»	4	28	20	24	16	40
— variegatum ..	A 3	H	4	4	»	4	»	»	28	20	4	20	20
Selaginella selaginoides ..	A 1	Ch	»	»	»	»	»	»	8	8	12	28	32
Loiseleuria procumbens .	A 2	Ch	»	»	»	4	»	»	12	8	8	4	»
Agrostis canina	E 3	H	»	»	»	»	»	»	12	»	8	20	
Arenaria ciliata	A 3	Ch	»	12	»	4	»	»	»	»	»	»	»
Bartschia alpina	A 2	H	»	4	»	»	»	»	20	4	»	»	8
Gentiana tenella	A 2	Th	»	»	»	»	»	»	8	»	»	»	»
Koenigia islandica.......	A 3	Th	4	28	»	»	»	»	»	»	»	»	4

TABLE 22 A CONTINUED.

			1	2	3	4	5	6	7	8	9	10	11
Pedicularis flammea.....	A 3	H	»	»	»	4	»	»	»	16	»	»	4
Pingvicula vulgaris......	E 4	H	12	»	»	8	»	»	20	»			
Rumex acetosa.........	E 3	H	»	»	»	»	»	»	»	»	»	»	4
Salix lanata.............	A 1	Ch	»	»	»	»	»	»	4				
Saxifraga Hirculus	A 3	H	»	»	»	»	»	»	»	4			
Sedum villosum..........	A 2	H	8	12	»	4	4	»	»				
Tofieldia palustris.......	A 2	H	12	»	»	»	»	»	48	»	8	»	
Trisetum spicatum......	A 3	H	12	16	»	12	4	»	36	»	»	12	8

TABLE 22 B.

Biological Spectra of the Melar and Betula nana Mo.

	1	2	3	4	5	6	7	8	9	10	11
Points sum.........	936	792	560	848	812	800	1304	1044	1064	1172	1080
Number of species..	34	31	20	32	24	21	36	32	29	29	32
Density of species ..	9.4	7.9	5.6	8.5	8.1	8.0	13.0	10.4	10.6	11.7	10.8
A.................	79.1	81.8	81.4	79.2	83.3	80.0	71.5	73 6	68.4	71.7	66.3
E.................	20.9	18.2	18.6	20.8	16.7	20.0	28.5	26.4	31.6	28.3	33.7
A 3	51.3	59.1	56.4	55.7	59.1	50.5	40.5	47.5	41.4	44.7	40.0
A 2	24.4	18.7	12.9	21.7	19.7	22.5	27.6	24.1	25.6	21.8	22.2
A 1	3.4	4.0	12.1	1.9	4.4	7.0	3.4	1.9	1.5	5.1	4.1
E 4	20.9	18.2	18.6	20.8	16.7	20.0	27.6	26.4	30.8	26.6	33.3
E 3	»	»	»	»	»	»	0.9	»	0.8	1.7	0.4
E 2	»	»	»	»	»	»	»	»	»	»	»
E 1	»	»	»	»	»	»	»	»	»	»	
Ch.................	50.0	49.0	59.3	53.3	53.2	49.5	46.6	45.2	49.2	47.4	47.8
H	37.6	36.4	31.4	34.0	36.5	39.5	40.8	36.0	33.5	39.9	33.3
G	10.7	9.1	8.6	11.8	8.4	10.5	11.7	17.2	16.9	12.6	17.8
HH	»	»	»	»	»	»	»	»	»	»	»
Th.................	1.7	5.6	0.7	0.9	2.0	0.5	0.9	1.5	0.4	»	1.1

will show. Some species occur exclusively or principally on melar, others exclusively or principally in the Betula nana mo, while a third group is common to both types of vegetation. The table shows more precisely which species belong to the respective groups. Physiognomically the chamaephytes dominate. A random selection of

the more conspicuous species includes: *Empetrum nigrum*, *Salix herbacea*, *S. glauca*, *Betula nana*, *Vaccinium uliginosum*, *Dryas octopetala*, *Silene acaulis*, and *Armeria vulgaris*. The species *Cassiope hypnoides* and *Loiseleuria procumbens* occur more frequently than in melar even though they are not as dominant as in the knolly mo.

Of hemicryptophytes and geophytes the following occur: *Polygonum viviparum*, *Juncus trifidus*, *Luzula spicata*. *Festuca ovina*, *Viscaria alpina*, *Galium Normanni*, *Thalictrum alpinum*, *Elyna Bellardi*, *Carex rigida*, *Festuca rubra*, and *Poa alpina*. Of pteridophytes *Selaginella selaginoides*, *Equisetum arvense*, and *E. variegatum* are met with.

Along the upper margin of the large snow patches there occurs a narrow belt in which *Betula nana* is the physiognomic dominant. This formation will be dealt with later, under the geiri vegetation.

The Knolly Mo. Cf. fig. 19 and table 23 A, 1—5.

This type of vegetation commonly occurs on flat sheltered slopes, on the lower slopes of elevations and ridges with melar above, in small hollows in the Betula nana mo, and on the borders of the snow patches. The surface is always knolly, but the knolls are neither very large nor very high. Judging by the position the snow-covering is deeper than in the two preceding types, the melar and the level mo, though less deep than in the snow patches. As regards moisture, the knolly mo occupies an intermediate position between the level mo and the jaðar vegetation.

The change in number of species and in density is continued from melar through the level mo to the knolly mo and here we have the values 35 and 15 respectively for the number of species and the density. Biologically the change is likevise continued: the Ch percentage has decreased, while the G and H percentages have increased. The E and A percentages have remained constant, while there is still a decrease in the A 3 percentage. There is a rise in the E 3 percentage.

While in the Betula nana mo Ch were dominant and H were the subordinate element, the reverse is the case in the knolly mo. Here H are the dominant. The respective averages for Ch and H in the two types of vegatation are 47 : 38 and 37 : 47.

The predominant chamaephytes are *Empetrum nigrum*, *Vaccinium*, and *Salix herbacea*. In more scattered growth there occur *Salix glauca*, *Silene acaulis*, *Armeria vulgaris*, *Dryas octopetala*, *Thy-*

Table 23 a.

The Mo and Jaðar Vegetation on Arnarvatnsheiði.

Localities 1—5 represent the mo vegetation, 6—10 the Jaðar vegetation. All localities situated near Úlfsvatn c. 500 m. above sea level. 1, 2, 5 examined on $^5/_8$ 1925; 8 on $^9/_8$, 3 and 6 on $^{12}/_8$, 4 and 9 on $^{13}/_8$, 7 and 10 on $^{14}/_8$ 1925. (7, 10. $^1/_{10}$ m^2; 1—6, 8—10, 25. $^1/_{10}$ m^2).

			1	2	3	4	5	6	7	8	9	10
Dryas octopetala	A 3	Ch	28	8	40	**52**		»		»		
Thymus serpyllum	E 4	Ch	20	»	24	12	»	4	»	»		
Cassiope hypnoides	A 2	Ch	20	**76**	20	48	36	»	»	»		
Loiseleuria procumbens	A 2	Ch	12	36	32	16	12	»	»	»	»	
Elyna Bellardi	A 3	H	**68**	24	**76**	**56**	»	16	»	»	8	4
Juncus trifidus	A 2	H	**56**	40	**60**	**64**	20	20	10	»	4	
Selaginella selaginoides	A 1	Ch	**80**	**72**	**76**	**72**	32	16	»	»	4	4
Agrostis canina	E 3	H	**76**	**60**	48	12	4	28	»	»		4
Trisetum spicatum	A 3	H	20	40	**56**	16	4	»	»	4	»	»
Tofieldia palustris	A 2	H	16	44	4	16	4	8	»	4		
Viscaria alpina	A 2	H	12	8	28	20	»	4	»	»	»	
Bartschia alpina	A 2	H	16	**56**	28	36	28	16	»	12	»	»
Empetrum nigrum	E 4	Ch	**100**	**100**	**96**	**96**	**96**	36	»	**52**	40	8
Vaccinium uliginosum	E 4	Ch	**80**	**76**	**92**	44	**68**	8	»	»	20	8
Luzula spicata	A 2	H	**68**	**68**	**56**	**68**	**52**	36	10	32	32	44
Silene acaulis	A 3	Ch	40	**64**	48	**60**	36	36	»	16	12	20
Equisetum variegatum	A 3	H	**76**	**88**	**92**	**60**	**64**	**64**	10	4	48	**60**
Salix herbacea	A 3	Ch	**88**	**100**	**84**	**76**	**88**	**84**	»	44	**60**	**100**
— glauca	A 3	Ch	20	24	32	48	**60**	**56**	20	48	48	44
Armeria vulgaris	A 3	Ch	16	8	20	44	12	28	»	8	16	16
Polygonum viviparum	A 3	G	**96**	**100**	**92**	**92**	**100**	**92**	**70**	**96**	**96**	**100**
Thalictrum alpinum	A 2	H	**88**	**88**	**96**	**88**	**80**	**100**	**70**	**92**	**80**	**88**
Carex rigida	A 3	G	44	**96**	**60**	**52**	**100**	**100**	**90**	**96**	**100**	**100**
Festuca rubra	E 4	H	**92**	**96**	**88**	**100**	**64**	**96**	**70**	**68**	44	40
— ovina	E 4	H	8	»	16	24	12	16	10	36	16	32
Poa alpina	A 2	H	20	40	40	48	4	**64**	»	16	16	40
— glauca	A 3	H	4	20	16	8	4	20	»	4	8	12
Rumex acetosa	E 3	H	8	8	24	20	16	40	30	16	**52**	48
Galium Normanni	A 1	H	44	**52**	**56**	24	8	**68**	30	24	32	28
Cerastium alpinum	A 2	Ch	8	»	4	32		32	30	20	48	8
Equisetum arvense	E 4	G	16	12		**80**	**80**	**80**	**60**	**76**	**80**	**96**
Deschampsia alpina	A 2	H	»	»			4	8		40	32	44
Salix phylicifolia	A 1	Ch		8				24	30	24	36	8
Cardamine pratensis	E 4	H				»	18	20	**60**	**64**	**80**	**76**
Taraxacum officinale	E 2	H						16	**80**	28	24	16
Potentilla verna	A 2	H						24	**80**	24	24	24
Poa pratensis	E 4	G							**90**		32	24
Agrostis tenuis	E 2	H									1	
Alchemilla minor	E 4	H							10			

Table 23 a continued.

			1	2	3	4	5	6	7	8	9	10
Anthoxanthum odoratum.	E 3	H	»	»	»	»	»	4	»	»	4	4
Betula nana	A 2	Ch	»	4	»	»	»	»	»	4	4	
Botrychium Lunaria... .	E 4	G	4	8	4	4	»	»	»	»	»	»
Calamagrostis neglecta...	E 4	H	»	»	»	»	16	»	10	»	32	32
Carex alpina	A 2	H	»	»	»	»	»	»	»	4	4	8
— dioica	E 4	G	»	»	»	»	4	»	»	»	»	12
— Goodenoughii	E 3	G	»	»	»	»	4	»	»	»	»	»
— rariflora	A 2	G	»	»	»	»	»	»	»	4	8	4
Cerastium trigynum	A 2	Ch	»	»	»	»	»	»	40	»	»	»
Deschampsia flexuosa....	E 3	H	12	8	4	4	»	12	40	»	»	»
Draba rupestris	A 1	Ch	»	»	»	»	»	4	40	»	»	4
Equisetum pratense	E 2	G	»	»	»	»	»	8	»	»	20	»
Eriophorum polystachyum	E 4	G	»	»	»	»	»	»	»	48	16	8
Euphrasia latifolia	A 2	Th	»	12	»	»	»	»	»	12	4	24
Gentiana nivalis	A 2	Th	»	»	»	»	»	»	»	4	»	»
— tenella.........	A 2	Th	»	4	4	»	»	»	20	»	»	4
Hieracium alpinum	A 2	H	»	»	4	»	»	»	»	»	»	»
Koenigia islandica.......	A 3	Th	»	»	»	»	»	»	10	8	»	
Luzula arcuata..........	A 3	H	»	»	4	»	»	»	»	»	»	»
— multiflora	E 3	H	»	»	»	»	»	4	»	»	12	»
Minuartia biflora	A 3	Ch	»	»	4	»	4	»	»	4	»	»
— verna	A 3	Ch	4	»	»	16	»	»	»	»	»	»
Pedicularis flammea	A 3	H	»	4	»	»	12	»	»	16	»	
Phleum alpinum	A 2	H	»	»	»	»	»	4	40	»	16	4
Pingvicula vulgaris	E 4	H	4	20	»	12	8	4	»	»	»	
Ranunculus acer	E 4	H	»	»	»	»	»	»	30	»	»	»
Salix lanata	A 1	Ch	»	»	»	»	»	»	»	12	4	»
Saxifraga Hirculus.......	A 3	H	»	»	»	»	16	4	»	16	8	
Sedum villosum	A 2	H	»	»	»	»	»	»	»	4	»	»
Sibbaldia procumbens ...	A 2	Ch	»	»	»	»	»	»	10	»	»	»
Veronica alpina	A 2	H	»	»	»	»	»	»	10	»	»	8
Viola palustris	E 3	H	»	»	»	»	»	»	40	»	4	

mus serpyllum, *Cassiope hypnoides*, and *Loiseleuria procumbens*. For the rest grasses and cyperaceous plants dominate, thus *Elyna Bellardi*, *Juncus trifidus*, *Luzula spicata*, and *Carex rigida*, further *Festuca rubra*, *F. ovina*, *Agrostis canina*, *Trisetum spicatum*, *Deschampsia flexuosa*, *Poa alpina* and *P. glauca*. Of herbaceous plants we find especially *Polygonum viviparum* and *Thalictrum alpinum*; less dominant plants are *Tofieldia palustris*, *Rumex acetosa*, *Viscaria alpina*, *Bartschia alpina*, *Galium Normanni*, and *Pinguicula vulgaris*. Pteridophytes are represented by *Selaginella selaginoides*, *Equisetum*

Table 23 b.

Biological Spectra of the Mo and Jaðar Vegetation.

	1	2	3	4	5	6	7	8	9	10
Points sum	1364	1572	1528	1520	1200	1304	1180	1084	1232	1208
Number of species	35	36	36	35	35	40	30	38	42	39
Density of species	13.6	15.7	15.3	15.2	12.0	13.0	11.8	10.8	12.3	12.1
A	**69.2**	**75.2**	**74.1**	**73.2**	**65.0**	**71.2**	**52.5**	**64.2**	**61.0**	**66.2**
E	**30.8**	**24.7**	**25.9**	**26.8**	**35.0**	**28.8**	**47.5**	**35.8**	**39.0**	**33.8**
A 3	37.5	36.6	41.1	40.3	41.7	40.8	19.5	35.4	36.7	38.4
A 2	22 6	30 3	24.3	26 7	20.0	21.8	24.6	23 2	18.2	24.2
A 1	9.1	8.4	8.6	6.3	3.3	8.6	8.5	5.5	6.2	3.6
E 4	23.8	19.8	20.9	24.5	33.2	20.2	31.4	31.7	29.2	27.8
E 3	7.0	4.8	5.0	2.4	2.0	6.7	9.3	1.5	5.8	4.6
E 2	»	»	»	»	»	1.8	6.8	2.6	3.9	1.3
E 1	»	»	»	»	»	»	»	»	»	»
Ch	**37.8**	**36.6**	**37.4**	**40.5**	**37.0**	25.1	14.4	21.4	23.7	17.9
H	**50.4**	**48.6**	**52.1**	**44.5**	**39.0**	**53.4**	**57.6**	**46.9**	**47.4**	**51.0**
G	11.7	13.7	10.2	15.0	24.0	**21.5**	**26.3**	**29.5**	**28.6**	**28.5**
HH	»	»	»	»	»	»	»	»	»	»
Th	»	1.0	0.3	»	»	»	2.5	2.2	0.3	2.3

variegatum, and *E. arvense*. *Botrychium Lunaria* occurs singly but constantly.

Thus to the above-mentioned physiognomic and biological differences between the level and the knolly mo must be added the following floristic differences: *Salix glauca* and *Betula nana* occur exclusively in the level mo. With a lower F.-percentage in the knolly mo we meet with *Festuca ovina, Minuartia verna, Silene acaulis*, and several others. Predominantly occurring in the knolly mo, we find: *Loiseleuria procumbens, Agrostis canina, Trisetum spicatum, Poa alpina, Deschampsia flexuosa, Carex rigida, Rumex acetosa, Selaginella, Equisetum variegatum, Bartschia alpina* and several others.

The two types of mo must thus be said to be well distinguished.

The Jaðar Vegetation. Cf. fig. 20 and table 23 A, 6—10.

In depressions between the moraine walls, on the borders of the mýrar, in small damp hollows in the mo, and as a fringe along the rivers the jaðar vegetation is met with. When typically deve-

loped it is easily distinguished from the other types of vegetation by the very large knolls of which the surface consists. These often attain a height of 1 m. or more and 1 or several m in diameter. The distance between the individual knolls is up to $^1/_2$ m. The jaðar vegetation belongs to moderately damp soil having a normal snow-covering in the winter. The composition of the vegetation can be shown to differ somewhat in the different localities, and possibly several types of highland jaðar may with good reason be established in the future, according to the degree and kind of moisture of the soil, and the amount of shelter provided by the snow-covering.

On an average, the density of species was c. 12, the number of species 35, in the jaðar localities examined by me. Ch have become much less dominant, the Ch percentage is only 20.5 and attains a relative minimum with this value, whereas the H percentage attains its maximum here, the average H percentage being 51.3. The G percentage which has risen steadily has reached a value of 27; it is noteworthy that the Th percentage attains a relative maximum of 1.5 in the jaðar vegetation.

The peculiarities to be noted in the species group spectrum are a diminution of the A percentage due in the main to a diminution of the A 3 percentage, a slight rise in the E 3 percentage, and the appearance of E 2 species in a quantity of 3.3 per cent.

The more conspicuous chamaephytes are *Empetrum nigrum* and the Salix species *Salix herbacea*, *glauca*, and *phylicifolia*; *Salix phylicifolia* is the characteristic dominant for jaðar. In more scattered growth there occur *Vaccinium uliginosum*, *Silene acaulis*, *Armeria vulgaris*, and *Cerastium alpinum*. For the rest it is H and G which characterise the vegetation, notably *Carex rigida*, and in addition, on the wettest soil, *Deschampsia alpina*. The more prominent species are *Polygonum viviparum*, *Thalictrum alpinum*, *Luzula spicata*, *Carex rigida*, *Equisetum arvense*, *E. variegatum*, *Festuca rubra*, *F. ovina*, *Deschampsia alpina*, *Poa alpina*, *Rumex acetosa*, *Galium Normanni*, *Cardamine pratensis*, *Taraxacum officinale*, *Potentilla verna*, *Poa pratensis*, *Calamagrostis neglecta*, *Viola palustris*, and *Saxifraga Hirculus*. A number of these species are characteristic of the jaðar.

A couple of types which I had not time to examine more closely shall be briefly mentioned here. One is the moss mo which St. Stefánsson has described from Grimstungnaheiði (1894, p. 201 (cf. p. 101). This type of vegetation was also found on Arnarvatns-

heiði, and there it seemed to be peculiar to hollows, the bottom of which consisted of large boulders over which *Grimmia* had spread a deep dense carpet with scattered specimens of *Carex rigida, Pedicularis flammea, Saxifraga Hirculus* and several others.

The other type is the jaðar along the banks of rivers. Physiognomically it resembles the jaðar further inland, but floristically it differs from it by the fact that a number of species such as *Carex Goodenoughii, Caltha palustris, Geum rivale, Comarum palustre,* and *Menyanthes trifoliata* either exclusively or practically exclusively occur here, and that merely as a narrow fringe only few metres wide along both sides of the stream. Since in the lowlands the species occur both in the mýri far from running water and along streams, their predilection for streams in the highlands cannot be due to any general property of these, such as an abundance of nourishment and oxygen, but must be referred to other causes. Since all the aforementioned plants are southern species, and since the presence of water in the highlands also otherwise favours the southern species, it seems natural to suppose that the more abundant occurrence of more southern plants in immediate association with running water is due to the fact that running water warms the soil more than stagnant water even though water in all cases acts as a reservoir of heat.

The Mýri and Flói Vegetation. Cf. figs. 21—22 and table 24 A, 1—13.

The mýri vegetation occurs in the dampest hollows and especially around the numerous lakes. A depression with mýri has the following appearance. On somewhat damper ground than the above-described jaðar with the large knolls, there occurs a Carex mýri with small knolls. The damper central parts have a level surface without knolls and consist of a mosaic of formations which are fairly distinct and visible at a distance by the different tinges they communicate to the landscape. The knolly Carex mýri may send out darker stripes into the mýri, while the level mýri itself consists of yellowish-green patches with *Carex rostrata* as the dominant, white patches in which *Eriophorum polystachyum* in fruit dominates, brown patches with *Carex rariflora,* and smaller or larger collections of water.

According to the degree of moisture of the soil, three zones of moisture may be distinguished: the knolly Carex mýri on the least

TABLE 24 A. **The Mýri and Flói Vegetation on Arnarvatnsheiði.**

Localities 1—4 represent the driest mýri nearest the jaðar, 5—9 the moister mýri passing into flói outwards, 10—13. Localities 1, 2, 5, 6, 7, 13 examined on 9/8 1925; 8, 11, 12 on 10/8, 10 on 12/8, 3, 4, 9 on 14/8 1925. (25. 1/10 m²).

			1	2	3	4	5	6	7	8	9	10	11	12	13
Euphrasia latifolia ...	A 2	Th	8	4	»	4									
Saxifraga Hirculus ...	A 3	H	32	8	»	8	»	»	»	»	»	»	»		
Festuca rubra........	E 4	H	8	4	8	»	»	»	»	»	»	»	»	»	»
— ovina........	E 4	H	16	8	12	»	»	»	»	»	»	»	»	»	
Carex alpina.........	A 2	H	8	4	»	12									
Luzula spicata	A 2	H	24	12	4	»	»	»	»	»	»	»	»	»	
Thalictrum alpinum ..	A 2	H	**52**	32	8	»	»	»	»	»	»	»	»	»	»
Carex rigida	A 3	G	24	**80**	**100**	20	»	»	»	»	»	»	»	»	»
— dioica	E 4	G	**96**	24	4	**64**	»	»	»	28	»	»	»	»	
Equisetum arvense ...	E 4	G	**84**	12	**92**	»	»	»	»	»	20	»	»	»	»
Empetrum nigrum ...	E 4	Ch	**60**	28	16	**76**	»	»	»	»	4	»	»	»	»
Vaccinium uliginosum.	E 4	Ch	44	12	20	**80**	»	4	»	32	»	»	»	»	
Salix herbacea	A 3	Ch	**80**	**72**	**92**	**60**	4	8	»	16	16	»	8	8	
— glauca	A 3	Ch	48	**72**	**64**	**56**	20	**64**	**80**	32	8	»	12	4	12
— phylicifolia.....	A 1	Ch	20	8	4	4	20	4	4	»	12	»	8	»	»
Equisetum variegatum	A 3	H	40	32	**60**	40	4	4	8	36	4	»	»	**52**	
Cardamine pratensis..	E 4	H	**64**	**56**	**72**	8	16	20	12	16	»	»	»	4	
Calamagrostis neglecta	E 4	H		48	**84**	**56**	16	12	36	»	**64**	36	»	12	36
Polygonum viviparum.	A 3	G	**100**	**100**	**96**	**96**	**84**	**88**	**92**	**100**	**68**	»	16	12	16
Eriophorum polystachyum	E 4	G	**88**	**84**	**52**	**92**	**100**	**100**	4	**100**	**100**	**100**	**100**	**100**	**100**
Carex rariflora	A 2	G	36	36	32	**96**	**100**	**100**	**100**	**100**	**100**	»	20	4	**68**
— chordorrhiza...	A 1	G	»	»	»	20	**64**	»	**64**	12	**100**	»	28	4	»
— rostrata	E 3	HH	»	»	»	12	8	»	**96**	»	»	20	»	»	16
— saxatilis	A 3	G	4	»	»	20	»	»	»	16	8	20	4	12	»
— Goodenoughii ..	E 3	G	»	»	»	»	»	»	»	»	»	»	»	»	**100**
Armeria vulgaris	A 3	Ch	»	4	»	»	»	»	»	»	»	»	»	»	»
Bartschia alpina	A 2	H	»	»	4	»	»	»	»	»	»	»	»	»	»
Betula nana	A 2	Ch	»	12	»	»	»	»	»	»	»	»	»	»	»
Comarum palustre ...	E 4	HH	»	»	4	»	»	»	»	»	»	»	»	»	»
Elyna Bellardi	A 3	H	»	4	»	»	»	»	»	»	»	»	»	»	»
Galium Normanni....	A 1	H	»	4	»	»	»	»	»	»	»	»	»	»	»
Juncus biglumis	A 3	H	»	»	»	»	»	»	»	4	»	»	»	»	»
— trifidus.......	A 2	H	4	»	»	»	»	»	»	»	»	»	»	»	»
— triglumis	A 3	H	»	»	»	»	»	»	»	12	»	»	»	»	»
Pedicularis flammea..	A 3	H	»	4	»	»	»	»	»	»	»	»	»	»	»
Poa alpina...........	A 2	H	»	4	»	»	»	»	»	»	»	»	»	»	»
— pratensis	E 4	G	»	»	4	»	»	»	»	»	»	»	»	»	»
Rumex acetosa.......	E 3	H	»	»	8	»	»	»	»	»	»	»	»	»	»
Trisetum spicatum ...	A 3	H	4	»	»	»	»	»	»	»	»	»	»	»	»

TABLE 24 B.

Biological Spectra of the Mýri and Flói Vegetation.

	1	2	3	4	5	6	7	8	9	10	11	12	13
Points sum	944	768	840	840	436	404	496	504	504	276	196	212	248
Number of species . .	23	27	22	20	11	10	10	13	12	5	8	10	6
Density of species . .	9.4	7.7	8.4	8.4	4.4	4.0	5.0	5.0	5.0	2.8	2.0	2.1	2.5
A	**51.3**	**64.1**	**55.2**	**53.8**	**67.9**	**66.3**	**70.2**	**65.1**	**62.7**	7.2	49.0	45.3	38.7
E	**48.7**	**53.9**	**44.8**	**46.2**	32.1	33.7	29.8	34.9	37.3	**92.8**	**51.0**	**54.7**	**61.3**
A 3.	35.2	49.0	49.0	37.6	25.7	40.6	36.3	42.9	20.6	7.2	20.4	41.5	11.3
A 2.	14.0	13.5	5.7	13.3	**22.9**	**24.8**	**20.2**	**19.8**	**19.8**	»	10.2	1.9	27.4
A 1.	2.1	1.6	0.5	2.9	**19.3**	1.0	**13.7**	2.4	**22.2**	»	18.4	1.9	
E 4.	48.7	35.9	43.8	44.7	30.3	33.7	10.5	34.9	37.3	49.3	51.0	54.7	54.8
E 3.	»	»	1.0	1.4	1.9	»	19.4	»	»	43.5	»	»	6.5
E 2.	»	»	»	»	»	»	»						
E 1.	»	»	»	»	»	»	»	»	»	»	»	»	
Ch	**26.7**	**27.1**	**23.3**	**32.9**	10.1	19.8	16.9	15.9	7.9	»	14.3	5.7	4.8
H	26.7	28.6	31.0	16.7	8.3	8.9	11.3	13.5	13.5	13.0	»	32.1	14.5
G	**45.7**	**43.8**	**45.2**	**48.6**	**79.8**	**71.2**	**52.4**	**70.6**	**78.6**	**79.7**	**85.7**	**62.3**	**74.2**
HH	»	»	0.5	1.4	1.8	»	19.4	»	»	7.2	»	»	6.5
Th	0.8	0.5	»	0.5	»	»	»	»	»	»	»	»	

damp soil, the Carex rariflora mýri on damper soil, and the Eriophorum polystachyum flói on the dampest ground. In table 24 A, Nos. 1—4 represent the knolly mýri, 5—9 the Carex rariflora mýri, and 10—13 the flói.

The knolly Carex mýri is most abundant in species and shows the greatest density of species of the mýri formations. The number of species is 23, and the density 8.5. Ch play a more prominent part here than in the jaðar and attain a relative maximum of 27.5 per cent. H show a strong decrease, while the rise in G is still continuing; the last Th meet with the first HH. The species group spectrum shows a large content of A 3 and E 4 species.

The physiognomic dominants are the chamaephytes and the Cyperaceæ, of the chamaephytes especially *Salix herbacea*, *S. glauca*, and *S. phylicifolia*, further *Empetrum nigrum* and *Vaccinium uliginosum*, of the Cyperaceæ *Eriophorum polystachyum*, *Carex rigida*, *C. dioica*, *C. rariflora*, and here and there *Carex alpina* and *C. sax-*

atilis. Of more or less importance are *Polygonum viviparum*, *Calamagrostis neglecta*, *Equisetum arvense* and *E. variegatum*, *Cardamine pratensis*, *Thalictrum alpinum*, *Luzula spicata*, *Festuca ovina*, *F. rubra*, and *Saxifraga Hirculus*.

The Carex rariflora Mýri. Cf. fig. 22 and table 24 A, 5—9.

On still damper ground the knolls disappear and with them a number of species, so that the species now only number 11.2, while the density of species is 4.7. The geophytes, comprising especially Cyperaceæ, form the bulk of the vegetation. The G percentage is 70.5, the HH percentage 4.2, the Ch and H percentages 14.1 and 11.1 respectively. The species group spectrum shows the peculiarity of a rise in the A percentage from 56 to 66 caused by a great rise in the A 2 and A 1 percentages; the A 3 percentage, on the other hand, is still reduced. The dominant species are *Carex rariflora* and *Eriophorum polystachyum*, also, in spots, *Carex chordorrhiza* and *C. rostrata*. Other frequently occurring plants are *Polygonum viviparum*, *Salix glauca*, and *Cardamine pratensis*.

The Eriophorum polystachyum Flói. Cf. Table 24 A, 10—13.

On the flói, the dampest soil clothed with plants, knolls are likewise absent, the ground is swampy as in the lowland flói, and not firm enough to walk on. The succession of changes in number of species, density of species, biological spectrum and species group spectrum in the mýri formations here reaches its climax, as was also the case in the lowland flói.

The sole dominant here is *Eriophorum polystachyum*, here and there a few mýri plants occur such as *Carex rariflora*, *C. chordorrhiza*, *C. rostrata*, *C. saxatilis*, *Polygonum viviparum*, *Salix glauca*, and *Calamagrostis neglecta*.

The Geiri Vegetation. Cf. table 25 A, 1—6 and figs. 23—25.

On slopes with a southern, western, and northern exposure a special vegetation, the snow patch or geiri vegetation, may be met with. Its peculiarities are conditioned by a deep and constant snow-covering in the winter. The snow falls early on these areas, covers them without intermission throughout the winter, and only melts well on in the spring.

The snow patches occur in two different forms. Most frequently the snow lies in long narrow bands on the southern, western, and

northern slopes of the hills (cf. fig. 23), abutting above on the melar, whence the soil rolls down on to it, and passing below into the knolly mo. More rarely the snow patches occur in the shape of large depressions having the form of a parabola in the western and southern slopes of the hills. The shape of these large patches of snow is very characteristic; above they are separated from the melar by a narrow steep edge. The sides of the snow patch slope strongly above, are less steep further down, and finally pass into the bottom of the patch which as a slightly hollow surface slopes gently towards the mouth of the snow patch. The shape most of all resembles a large shovel dug into the slope. The bed of a rivulet extends some way into the patch. Outwardly this form, too, passes into the knolly mo.

The surface is level and without knolls in both forms of snow patch, as may be seen with sufficient plainness in the figures.

While the vegetation is uniform throughout the whole snow patch in the first type, differing only according to the exposure, a distinction can be drawn in large snow patches between a marginal zone, the vegetation on the sides, and a bottom vegetation. The vegetation is most characteristic in the large snow patches, a number of snow patch plants being exclusively found here, just as the marginal zone is a formation peculiar to the large snow patches. As regards the vegetation of the bottom, it seems to correspond to that af smaller snow patches with a northern exposure, while the vegetation of the sides corresponds to that of smaller snow patches with a southern exposure. Hence the floristic relations of the snow patches may be dealt with under one head, the following three formations requiring to be treated: 1) a marginal zone with *Betula nana*, and possibly *Juniperus communis*, 2) a Geranium belt comprising small patches having a southern or western exposure and the vegetation of the sides of the large snow patches, and 3) the bottom vegetation, which comprises, in addition, the vegetation of snow patches having a northern exposure. Table 25 A, 1—6 shows the circling results for the vegetation of the snow patches. No. 1 is the vegetation of the marginal zone, Nos. 2—4 the Geranium belt, and Nos. 5—6 the bottom vegetation. Nos. 1, 2—3, and 6 originate from the same large snow patch, 5 and 4 represent the smaller patches, respectively with a northern and a southern exposure.

TABLE 25 A. **The Geiri Vegetation on Arnarvatnsheiði.**

Locality 1 represents the marginal vegetation of the snow patch, 2—4 the vegetation on the sides of the snow patch, 5—6 the vegetation on the bottom of the snow patch. No. 2 examined on 5/8 1925; 1, 3, 6 on 6/8, 4 on 8/8, 5 on 9/8 1925. (25. 1/10 m^2).

			1	2	3	4	5	6
Betula nana	A 2	Ch	**72**	»	»	»		
Thymus serpyllum	E 4	Ch	48	»	»	12	»	
Dryas octopetala	A 3	Ch	16	»	»	»	»	
Silene acaulis	A 3	Ch	12	»	4	»	»	
Armeria vulgaris	A 3	Ch	16	»	»			
Juncus trifidus	A 2	H	24	»	8	8	»	
Elyna Bellardi	A 3	H	12	»	»	4	»	
Geranium silvaticum	E 3	H	12	**96**	**84**	**100**	4	»
Vaccinium uliginosum	E 4	Ch	**88**	**64**	**96**	**96**	**100**	
Salix herbacea	A 3	Ch	**68**	**96**	**88**	**80**	**100**	**100**
— glauca	A 3	Ch	**52**	**64**	**56**	44	**84**	**92**
— phylicifolia	A 1	Ch	8	**56**	28	16	12	
Empetrum nigrum	E 4	Ch	**92**	**68**	**68**	**88**	**100**	»
Polygonum viviparum	A 3	G	**76**	**84**	**52**	**68**	**64**	44
Thalictrum alpinum	A 2	H	**88**	**80**	**100**	**100**	**72**	16
Carex rigida	A 3	G	**80**	**72**	**92**	**88**	**92**	**76**
Deschampsia flexuosa	E 3	H	**72**	**96**	**96**	**100**	**92**	**56**
Festuca rubra	E 4	H	**76**	**60**	12	44	48	**76**
Agrostis canina	E 3	H	24	**68**	16	**80**	**80**	**96**
Hierochloë odorata	E 2	G	4	**56**	8	20	20	12
Anthoxanthum odoratum	E 3	H	8	**88**	8	**60**	»	4
Selaginella selaginoides	A 1	Ch	20	16	16	**56**	»	»
Galium Normanni	A 1	H	**56**	8	8	**68**	»	
— verum	E 1	H	20	12	28	**52**	»	»
Equisetum arvense	E 4	G	16	**60**	16	8	48	**84**
— variegatum	A 3	H	36	»	16	8	20	12
Rumex acetosa	E 3	H	12	32	44	4	4	**64**
Phleum alpinum	A 2	H	»	36	12	12	8	24
Ranunculus acer	E 4	H	»	44	28	4	»	20
Viola palustris	E 3	H	8	24	48	»	40	20
Taraxacum officinale	E 2	H	»	12	48	»	40	20
Agrostis tenuis	E 2	H	4	»	**64**	»	»	»
Alchemilla minor	E 4	H	»	20	16	4	»	
Sibbaldia procumbens	A 2	Ch	»	36	»	»	»	44
Gnaphalium supinum	A 2	Ch	»	24	»	»	»	**72**
Alchemilla alpina	A 2	Ch	4	»	16	4	»	»
Betula alpestris	A 1?	Ch	»	»	»	4	»	»
Botrychium Lunaria	E 4	G	4	»	»	8	»	»
Calamagrostis neglecta	E 4	H	»	»	»	»	»	8

TABLE 25 A CONTINUED.

			1	2	3	4	5	6
Cardamine pratensis	E 4	H	»	»	4			
Deschampsia caespitosa..	E 2	H	»	»	4	»	»	
Festuca ovina	E 4	H	12	»	»	»	4	
Gentiana nivalis.........	A 2	Th	»	»	»	8	»	
Habenaria viridis	A 1	G	»	»	»	12		
Hieracium alpinum	A 2	H	»	»	»	4		
Leontodon autumnalis...	E 3	H	»	»	»	»	»	12
Luzula spicata	A 2	H	20	8	»	»	»	»
Poa alpina..............	A 2	H	20	44	»	8	»	12
— glauca..............	A 3	H	»	4	»	»	»	
Potentilla verna	A 2	H	»	»	»	»	12	»
Veronica alpina	A 2	H	»	»	4	»	»	»

TABLE 25 B. **Biological Spectra of the Geiri Vegetation.**

	1	2	3	4	5	6
Points sum..................	1180	1428	1192	1272	1004	996
Number of species	34	29	33	33	20	22
Density of species.............	11.8	14.3	11.9	12.7	10.0	10.0
A	**57.6**	44.0	41.9	46.5	46.2	49.4
E	**42.4**	**56.0**	**58.1**	**53.5**	**53.8**	**50.6**
A 3.........................	**31.2**	22.4	25.8	23.0	35.9	32.5
A 2.........................	19.3	16.0	11.7	11.3	9.2	16.9
A 1.........................	7.1	5.6	4.4	12.3	1.2	»
E 4.........................	28.5	22.1	20.5	20.8	29.9	18.9
E 3.........................	11.5	**28.3**	**24.8**	**27.0**	17.9	28.5
E 2.........................	0.7	4.8	**10.4**	1.6	6.0	3.2
E 1.........................	1.7	0.8	2.3	4.1	»	»
Ch.........................	**42.0**	29.7	31.2	31.4	39.4	30.9
H	42.7	**51.3**	**54.7**	**51.9**	**38.2**	**47.4**
G	15.3	19.0	14.1	16.1	22.3	21.7
HH	»	»	»	»	»	»
Th	»	»	»	0.6	»	»

The Marginal Zone.

Along the entire upper edge of the large snow patches there occurs a narrow belt, rarely more than 1—2 metres wide, where a

number of chamaephytes attain a luxuriant development. The dominant species are *Betula nana*, *Empetrum nigrum*, *Salix glauca* and *herbacea*, and *Vaccinium uliginosum*; in some snow patches one may likewise find *Juniperus communis* and *Betula alpestris*. All species attain a vigorous growth and form a dense mat of shrub-like vegetation. Beneath the chamaephytes there is a bottom layer formed of species like *Deschampsia flexuosa*, *Festuca rubra*, *Carex rigida*, *Polygonum viviparum*, *Thalictrum alpinum*, *Galium Normanni*, and a number of mo plants such as *Thymus Serpyllum*, *Dryas octopetala*, *Silene acaulis*, *Armeria vulgaris*, *Juncus trifidus*, *Elyna Bellardi*, *Luzula spicata* and several others.

The Geranium silvaticum Belt.

This formation initiates the snow patch vegetation proper. As stated above, it occurs on the steep sides of the large snow patches and in the smaller ones on slopes having a southern and western exposure.

H are considerably more dominant here than in the marginal zone whereas Ch are of minor importance. The most conspicuous plant is *Geranium silvaticum* (cf. fig. 25). Under this plant and mixed with it there occurs a dense vegetation of Ch and herbs: *Vaccinium uliginosum*, *Salix herbacea*, *S. glauca*, and *S. phylicifolia*, *Empetrum nigrum*, *Polygonum viviparum*, *Thalictrum alpinum*, *Equisetum arvense*, *Carex rigida*, *Deschampsia flexuosa*, *Agrostis canina* and *A. tenuis*, *Festuca rubra*, *Hierochloë odorata*, *Anthoxanthum odoratum*, *Phleum alpinum*, *Poa alpina*, *Rumex acetosa*, *Ranunculus acer*, *Viola palustris*, *Taraxacum officinale*, *Galium verum*, *Alchemilla alpina*, and *A. minor*, and *Sibbaldia procumbens*.

The table shows more precisely the quantitative distribution of the individual species. In the main the three localities examined by me are in accordance even though some few species deviate. The deviations probably express differences of environment, but the material is so small that there is no reason for a more detailed discussion.

The Bottom Vegetation.

Covering the bottom of the snow patch, below the Geranium belt and well marked off from it, there occurs a Salix glauca-Gnaphalium supinum formation. This formation is somewhat poorer in species than the Geranium belt above. The density of

species is likewise less, 10.0 as against 14.3. The dominant or typical species are *Salix glauca, S. herbacea, Sibbaldia procumbens,* and *Gnaphalium supinum. Vaccinium uliginosum, Empetrum nigrum,* and *Salix phylicifolia* have entirely disappeared. Of more or less dominant species we may mention *Equisetum arvense, Carex rigida, Deschampsia flexuosa, Agrostis canina, Festuca rubra, Rumex acetosa, Viola palustris, Taraxacum* and *Leontodon.*

Table 25 A, 5 shows the circling results for a smaller snow patch having a northern exposure. In its broad features this locality corresponds to the bottom vegetation of the large snow patches. Floristically there is the difference that *Vaccinium uliginosum* and *Empetrum nigrum* are present in the small snow patches, while *Sibbaldia procumbens* and *Gnaphalium supinum* are only present in the larger ones.

Just as, within the mýri formations, the flói forms the extreme point in a sequence of changes conditioned by the length of the period when the ground is covered with water and the depth of the water-layer, so also, in the formations lying above the ground-water, the geiri shows a succession of changes conditioned by the length of time that the ground is covered with snow and the depth of the layer of snow. Passing from melar by way of the mo to geiri, the depth and duration of the snow-covering increases more and more. Melar is without snow or almost without snow throughout the winter, the mo has the snow-covering normal to the area, while the geiri is already covered at the first snowfall in the autumn, retains a deep and constant snow-covering throughout the winter, and only becomes bare again when the snow melts far on in the spring.

Now these conditions have the following effect on the vegetation. Where the snow-covering is slight, it consists principally of arctic species and life-forms, whereas, where it is deep, it consists of southern species and life-forms.

Thus melar has a Ch percentage of 52, an H percentage of 36, an A percentage of 81 and an A 3 percentage of 55. The E percentage is 0.

The mo (the knolly mo) has a Ch percentage of 38, an H percentage of 47, the A percentage is 71, the A 3 percentage 39, and the E 3 percentage 4.

The geiri (the Geranium silvaticum belt) has a Ch percentage

of 31, the H percentage is 53, the A percentage 44, the A 3 percentage 24, and the E (3—2—1) percentage 35.

The Geranium belt represents the area where the characteristics peculiar to geiri are most striking. If we pass from the marginal zone through the Geranium belt to the bottom vegetation, or from a snow patch with a southern exposure to one with a northern exposure, the southern contingent is largest in the Geranium belt or the snow patch with the southern exposure, while it again decreases in the bottom vegetation or on the northern slope. This is especially due to a decrease in the southernmost E subgroups.

Looking for the cause of this change we find it in the unusually long period during which the formations in question are covered with snow. In the case of the southern types of plants, which obtain the most favourable life-conditions in the Geranium belt (that is to say, the greatest possible protection from the winter cold and the most favourable temperature in the period of vegetation), the long-lasting snow-covering causes the vegetation period to become too short for these plants.

The number and density of species which attain their highest values, 36 and 15 respectively, in the mo, have the values 32 and 13 in the Geranium belt. This diminution is continued in the bottom vegetation, so that here the number of species is only 21 and the density 10.

If these changes are continued, with the successive diminution of the number of species and the quantity of southern species, as a final result we may anticipate to find, at still greater altitudes above the sea, the Salix herbacea and Sibbaldia formations described by Helgi Jónsson and at still higher levels the Anthelia-vegetation.

At the level at which Arnarvatnsheiði is situated, in the lower zone of the mountain region, we have thus the following types of vegetation.

I. **Melar**, conditioned by a slight snow-covering and a comparatively strong desiccation of the soil.

II. **The Betula nana mo**, where the snow-covering is deeper and the moisture of the soil greater: while the melar vegetation is peculiar to the denudation area of solifluction, the Betula nana mo is peculiar to the accumulation area.

III. **The knolly mo.** The snow-covering and moisture of the soil are still greater. No solifluction, but incipient formation of knolls.

IV. **Jaðar**, peculiar to moderately moist soil with normal snow-covering and maximum formation of knolls.

V. **Mýri.** The soil is constantly moist, the ground-water coming up above the surface. Two formations may be distinguished, an upper, more dry, formation in which knolls occur, and a lower, more moist, formation in which the surface is level and without knolls.

VI. **Flói.** Constantly covered with water, the bottom level, no knoll formation.

VII. **Geiri.** Snow-covering deep, bottom comparatively moist, especially in the lower formations, surface level, no knolls.

The types of vegetation in other parts of the highlands seem to correspond to these.

VI. THE DISTRIBUTION OF SPECIES, SPECIES-GROUPS, AND LIFE-FORMS IN THE FORMATIONS, ARRANGED ACCORDING TO INCREASING PREVALENCE OF ONE AND THE SAME EXTERNAL FACTOR

In the two preceding chapters we have treated in more detail a series of Icelandic formations with respect to their environment and their floristic and biological characteristics. A very important part still remains to be treated, viz. a determination of the areas covered by the individual species within the tracts examined.

The most obvious method of determination would be to map the formations within the tracts examined, and determine their areas on the basis hereof. But this work would involve too much time and trouble if it were to be accomplished in a fairly reliable way.

A more practical method has been worked out by Thore Fries in 1919. The mode of procedure in this method, "the synecological line taxation method", is as follows. A system of definite lines, drawn according to more precise rules, is laid down, and the lengths of line covering the respective formations, are then measured. If the system of lines is correctly laid, that is to say, if the lines are laid sufficiently close together, the sum of the lengths of line covering a given formation will afford a measure for the area covered by the formation within the tract examined, and the proportion of the length of line covering a given formation to the total length of the line system will correspond to the proportion of the area covered by the formation to the total area of the tract examined. (Th. Fries, 1919, p. 8).

In my investigations of the Icelandic vegetation I did not employ Fries's line taxation method, a fact which I have often regretted during my elaboration of the material, but during investigations in Denmark I have often experienced how practical this method is compared with the usual mapping of the formations of an area. Thus I have the same experience of the line taxation method as has Thore Fries of Raunkiær's circling method . . . .

"the method, in my opinion, constitutes an ingenious and satisfactory solution of the problem." (Th. Fries, 1919, p. 4).

I can likewise fully support the author when he goes on to say, "Raunkiær's circling method and the synecological line taxation method complete each other. By the former we obtain exact knowledge of the nature of the units, by the latter of their area and distribution. Synecological plant geography should be able to make great progress in exactitude by these two methods. Synecology now need no more rank last in this respect among the various branches of botany, on the contrary, it should soon be able to take up its position as one of the first."

However, the results which these two methods will be able to produce, viz. an exact description of the plant series of the face of the earth, only constitute one aspect of plant geography, the geographical aspect. For such a description is primarily of importance in its bearing on geography. The botanical aspect proper will only appear when, in addition, we investigate the external factors which determine the distribution of the individual biological or systematic units.

If we follow the ordinary scientific method of investigating the facts in connection with a given unit by varying only one external factor at a time and as far as possible keeping all the other factors constant, this means, in the case of the doctrine of formations, that we must primarily examine the distribution of the individual species within the formations, arranged according to increasing prevalence of one and the same external factor. The resulting facts may then be made the basis of more detailed ecological considerations.

In the present chapter we have examined the distribution of a series of Icelandic species partly in relation to the Icelandic scale of moisture, partly in relation to the scale of snow-covering. The material employed is the same which was utilised for the formation statistics of the two preceding chapters. On the basis of this material we have further examined the distribution of Raunkiær's life-forms and the species groups in relation to the above-mentioned two scales.

The Scale of Moisture.

Under the treatment of the formations in the localities examined the degree of moisture has been more precisely described.

We may distinguish between an area in which the moisture of the soil is entirely dependent on the precipitation throughout the year, an area whose moisture throughout the year depends also on the ground-water, and an intermediate area in which the moisture of the soil depends on the precipitation in the summer, while in the winter it is also dependent on the ground-water. This area is represented by the jaðar vegetation.

If, on a gently sloping surface, we pass upwards from the jaðar vegetation, we may distinguish here between three different zones of moisture: a lower zone in the mo, where the influence of the ground-water is still demonstrable, the mo itself, where this influence no longer exists, and an upper zone (the melar vegetation), which, on account of its open vegetation, is exposed to a stronger desiccation than the more densely covered mo.

If, from the jaðar vegetation, we pass downwards, we can likewise distinguish between three different zones of moisture: an upper mýri formation, not very damp in the summer, a lower mýri formation saturated with water, and finally the flói, which is covered with water throughout the year.

Thus we may distinguish between 7 different zones of moisture in Iceland.

Zone I comprises the Elyna mo at Bjørk and the melar vegetation on Lýngdalsheiði, at Lækjamót, and on Arnarvatnsheiði.

Zone II comprises the Arctostaphylos mo at Bjørk, the ordinary mo at Lýngdalsheiði, the high mo at Lækjamót, the mo at Norðtunga, and the Betula nana mo on Arnarvatnsheiði.

Zone III comprises the Calluna-Empetrum mo at Bjørk, the moist mo on Lýndalsheiði, and at Lækjamót, and the knolly mo on Arnarvatnsheiði.

Zone IV comprises the jaðar vegetation at Bjørk, on Lýngdalsheiði, and on Arnarvatnsheiði.

Zone V comprises the Salix mýri at Bjørk and on Lýngdalsheiði, and the knolly mýri on Arnarvatnsheiði.

Zone VI comprises the Betula nana mýri at Lækjamót and Bjørk and on Lýngdalsheiði, and the level mýri on Arnarvatnsheiði.

Zone VII, finally, comprises the flói vegetation at Bjørk, on Lýngdalsheiði at Lækjamót, and on Arnarvatnsheiði.

These 7 zones may be pointed out without difficulty wherever the ground does not slope too steeply. As soon as the ground becomes more rugged and uneven, irregularities in the distribution of the zones may be observed. One or more zones will not be developed; thus moist mýri may be observed to adjoin high mo without the intermediate zones having attained development. The interrelationship of the zones can, however, be confirmed wherever the mo, or the mýri, is the dominant feature of the landscape. In hollows in the mo the jaðar will always be the first type of vegetation to be met with, and with the progressive size and depth of the depression the other types will follow in the above-described sequence. Wherever an elevation occurs in the mýri, the types of vegetation will succeed each other from the edge of the mýri to the summit of the elevation in the same regular way in conformity to law. These conditions are repeated again and again in every part of the island.

Table 26 shows the distribution of the life-forms and the species-groups in relation to the scale of moisture in the various series of investigations. The Roman numerals I—VII correspond to the 7 zones of moisture mentioned above.

Life Forms. Their Distribution in Relation to the Scale of Moisture.

In a previous chapter (pp. 13—33) the influence of the climate on the prevalence of species-groups and life-forms in the flora was subjected to a more detailed investigation. As far as the life-forms were concerned Ch proved of special interest by the close correlation between the rise in the Ch percentage and the severity of the climate. Passing round the coast from South Iceland by way of western and northern Iceland to East Iceland, the Ch percentage showed a continuous rise, and passing from the level of the sea towards the snow-line, the same was the case, only in even greater degree. The same was the case with the A percentage.

The statistical investigations of the formations confirm this. Thus, if we compare the Ch percentage of the Elyna mo at Bjork, the formation in the southern lowlands which is most arctic in character, with the melar at Lækjamót, the most pronounced arctic formation in the north country (both localities at a height of c. 100 m.), we shall see that in the former case the Ch percentage is 28, in

the latter 45. On Arnavatnsheiði, at a level of c. 500 m., the same formation shows a Ch percentage of 52.

Taking the mosathembur vegetation of Lýngdalsheiði from altitudes of c. 250 m., 332 m., and 400 m, we get the following scale for the Ch percentage: 10→55→68, with a corresponding rise of the A percentage: 75→90→100.

Thus the influence of the cold on the Ch and A species is beyond all doubt.

Table 26 shows the distribution of the life-forms in relation to the scale of moisture. A remarkable circumstance appears in connection with the chamaephytes. From a comparative minimum in zone IV (the jaðar vegetation) the Ch percentage increases in value, upwards as well as downwards. This applies equally to the Bjørk series, the Lýngdalsheiði series, and the highland series. In the Lækjamót series the increase does not appear in the lower part of the scale for the halla mýri series, whereas the rule seems to apply to the fór mýri series here.

It is difficult to find any plausible reason why Ch should thrive best in the mo and the mýri, and badly in the intermediate jaðar. Anyhow, it is a fact that the environment in the jaðar is unfavourable to Ch. Species such as *Empetrum nigrum*, *Vaccinium uliginosum*, and *Betula nana* occur with a higher F.-percentage above as well as below the jaðar.

Possibly the cause may be found in the annual variations in the level of the water. It is of minor importance to Ch whether the moisture is great or small, if only it is the same all the time. If great variations take place, as is the case in jaðar where the plants grow now on damp, now on dry soil, Ch decline.

On the heaths of Jutland it may often be observed how great variations in the water level tend to kill the chamaephytes, and at the level of moisture corresponding to the jaðar, viz. the edge of the bog, the following facts may be observed. In the middle of the heath where the variations are only small, the chamaephytes play a prominent part in the composition of the vegetation, near the valley of the river where the variations are greater, the chamaephytes disappear. In a series of investigations on this zone of moisture at Nørholm Heath the former formation showed an average Ch percentage of 55, while the latter formation had only a Ch percentage of 4.

Possibly the depression of the Ch percentage in Zone IV may be referred to similar circumstances.

If we compare the A percentage and the Ch percentage in the scale of moisture, both series are seen to take a corresponding course with a relative minimum in Zone IV. Thus the depression may perhaps also be due to the temperature conditions which are more favourable to the vegetation in this zone than in those above and below.

The hemicryptophytes are peculiar to the upper, drier part of the scale of moisture with perhaps a slight indication of a rise from Zone I to Zone IV. From this zone onward there is, at any rate, a strong decrease. The maximum of the hemicryptophytes in the moderately moist area which coincides with the relative minimum of the chamaephytes is most pronounced in the highland tracts. The hemicryptophytes dominate more in the lowland than in the highland formations, and of the lowland formations those of the south country are more abundantly provided with H than those of the north country. Thus, in contrast to the chamaephytes, the hemicryptophytes seem to thrive best in a moderately moist environment of favourable temperature. This appears with even greater distinctness in the distribution of the species, as is sufficiently evident from the biological spectra in table 8 for the heath and mo vegetation, in contrast to the vegetation of the littoral meadows and the grassland.

The therophytes play no very great part in the composition of the vegetation in Iceland. They occur most abundantly in the relatively continental parts of Iceland, the highlands and the north country; in the rainy south country they hardly occur at all in the typical formations. In the north country they occur more abundantly in the lowlands than in the highlands.

In the scale of moisture Th attain two maxima, one in Zone I (melar), and one in Zone IV (jaðar). In the part showing the greatest moisture they do not occur at all. The rise in Zone IV is of special interest: for the individuals it is most marked in the highland series, for the species it is even more marked than for the individuals, as shown by the biological spectra of the vegetation of the littoral meadows and the grassland in Vestfirðir. The Th percentage for these two types of vegetation which correspond to the jaðar vegetation, is 15—16, for the heath and mo vegetation it is only 1—8.

As previously mentioned, the flag vegetation is peculiar to this level, and this type of vegetation has just those characteristics which were pointed out for Zone IV, or the jaðar vegetation, viz. a low chamaephyte percentage and high H and Th percentages; these conditions are, however, more pronounced in the flag than in the jaðar vegetation. Thus the forces which produce and sustain the flag vegetation act, though in slighter degree, wherever this level of moisture occurs, even where no flag is developed.

The cryptophytes, i. e. the helophytes and geophytes, are peculiar to the lower sections of the scale of moisture, just as Ch, Th, and H are peculiar to its upper sections. HH are most abundant in the lowlands and the south country, decreasing in quantity as we pass to higher levels. This agrees with the HH percentage in the Greenlandish local floras where, as previously shown, the HH percentage decreases from south to north along the west coast as well as the east coast.

As regards the distribution of HH in the scale of moisture, they naturally occur in the greatest quantity in the flói on soil that is constantly covered with water; thence they decrease strongly through the mýri, until they disappear entirely in jaðar.

The geophytes have a similar distribution. In Zone VII, the dampest section of the scale, they attain their maximum; thence the G percentage decreases strongly and steadily throughout the scale until, in Zone I, they attain their minimum which is lowest in the north country and highland tracts, highest in the south country. Thus the geophytes, on this point too, present a contrast to the therophytes and chamaephytes.

In regard to species the cryptophytes show the same conformity to law; thus the freshwater vegetation of Vestfirðir has an HH percentage of 70, the mýri vegetation an HH percentage of only 9. In the same locality the G percentage of the mýri is 25, of the mo, 14, and of melar only 9.

We have now seen the distribution of Raunkiær's life-forms in the Icelandic scale of moisture. From the circling results it appears that the individual life-forms attain their maximum development at different grades of the scale. Passing from the bottom to the top of the scale, the following sequence appears

Heloph. → Geoph. → Hemicryptoph. → Theroph. & Chamaeph.

In the 4 moisture series examined so far, the life-forms show, in the main, the same sequence.

If the biological spectra are based on species lists alone, we get the same sequence.

This distribution must be regarded as more specific to the life-forms than to conditions in Iceland.

In Denmark the vegetation of Nørholm Heath has been examined with the same minute graduation of the external factors as in Iceland. The sequence of the maxima of the life-forms in the scale of moisture was the same on Nørholm Heath (which, however. had more than 7 grades) as in Iceland, viz. HH. G, H, and Ch from below upwards. The rise in the Ch percentage in the lower section of the scale is not found here, however; on the other hand, there is a rise of the H percentage.

Raunkiær (1909, 1912), C. Olsen (1914, 1921), and Grøntved (1927) examined the vegetation on solid soil exposed to the sun. From their researches it will likewise appear that, if biological spectra for the various (more diffusely limited) zones of moisture are worked out on the basis of the circling results, the sequence will be HH, G, H, Ch, and Th.

If biological spectra for the various zones of moisture from sunny open solid soil were worked out on the basis of the species lists alone, the sequence of life-forms was still seen to be the same.

The correlation between moisture of soil and life-form pointed out above must be said, therefore, to be generally valid. In considering the physical causes active in the formation of life-forms, a knowledge of this correlation is indispensable.

The Species-Groups. Their Distribution in the Scale of Moisture.

On the basis of particulars of the presence and quantitative distribution of the individual species in northern Europe and the adjacent arctic regions we have, in a previous chapter, divided the Icelandic flora into groups according to the temperature requirements of the species.

The flora was first divided into two large groups: the A group which has its main distribution in arctic regions to the north of or, in mountain regions, above. the tree limit, the 20 per cent Ch biochore; and the E group which has its main distribution in the

TABLE 26. **The Distribution of Species Groups and Life Forms in the Scale of Moisture.**

1. The Björk Series. 2. The Lýngdalsheiði Series. 3. The Lækjamót Series. 4. The Arnarvatnsheiði Series. (Cfr. the text).

	Pointssum	Number of species	Density of species	A	E	A3	A2	A1	E4	E3	E2	E1	Ph	Ch	H	G	HH	Th
1. I	4536	29	11.4	**52**	48	**30**	11	11	30	11	4	2	»	**28**	56	16	»	»
II	4096	30	13.6	33	67	18	9	6	33	13	**21**	0.3	»	**39**	47	14	»	0.2
III	4436	**40**	**14.8**	39	61	19	10	10	33	11	**17**	0.5	»	29	**52**	18	»	0.1
IV	2756	**42**	13.8	36	64	15	8	13	36	14	**15**	0.3	»	22	**54**	**23**	2	0.2
V	2768	**39**	13.9	37	63	14	11	11	43	18	3	»	»	25	34	**33**	8	»
VI	1920	26	9.6	41	59	10	17	13	41	15	3	»	»	**33**	9	**45**	**13**	»
VII	376	5	1.9	24	**76**	»	3	22	9	**67**	»	»	»	»	»	**63**	**37**	
2. I	3852	18	5.5	60	40	36	19	5	30	10	0.5	0.2	»	**43**	39	18	»	»
II	3644	34	13.3	50	50	29	10	11	25	14	**10**	1	»	26	**56**	17	»	0.3
III	1384	32	13.8	51	49	23	13	15	24	15	**11**	»	»	23	**59**	18	»	»
IV	1376	38	13.8	43	57	20	12	11	30	15	**12**	»	»	12	**53**	**34**	1	0.3
V	1076	34	10.8	47	52	21	17	9	33	16	4	»	»	19	34	**41**	6	0.4
VI	2832	21	9.4	51	49	17	22	13	34	15	»	»	»	**29**	13	**52**	6	»
VII	228	2	1.1	2	98	»	»	2	36	**63**	»	»	»	»	36	**65**	»	»
3. 1	2058	27	6.9	75	25	52	16	7	24	1	1	0.2	»	**45**	47	5	»	3
2	3480	39	17.4	64	36	39	18	7	25	7	4	0.1	»	**35**	49	14	»	2
3	3168	43	15.9	57	43	33	16	8	23	**10**	8	2	»	25	**58**	14	»	3
4	2228	33	11.2	50	50	23	25	2	24	**17**	9	»	»	13	**40**	**46**	»	2
5	780	29	7.8	51	49	17	24	10	24	**17**	**8**	»	»	11	19	**62**	8	1
6	1172	14	5.9	30	70	22	17	2	26	**30**	**15**	»	»	0.3	25	**65**	9	»
5′	908	27	9.1	44	56	19	23	1	44	13	»	»	»	23	22	**55**	»	»
6′	204	3	2.0	51	49	2	»	49	49	»	»	»	»	»	»	**100**	»	»
4. I	4748	27	7.9	81	19	55	20	6	19	»	»	»	»	**52**	36	10	»	2
II	5664	32	11.3	70	30	43	24	3	29	1	»	»	»	**48**	37	15	»	1
III	7184	35	14.4	71	29	39	25	7	24	4	»	»	»	38	**47**	15	»	0.3
IV	6008	38	12.0	63	37	34	22	7	28	6	3	»	»	21	**51**	**27**	»	2
V	3392	23	8.5	56	44	43	12	2	43	1	»	»	»	28	26	**46**	1	1
VI	2344	11	4.7	66	34	33	22	12	29	4	»	»	»	14	11	**71**	4	»
VII	932	7	2.4	35	65	20	10	5	53	13	»	»	»	6	15	**75**	4	»
Average I .	13.136	25	8.3	**64**	36	**40**	17	7	26	7	2	1	»	**41**	44	15	»	0.7
II ..	16.404	32	12.7	**51**	49	**30**	14	7	29	9	**10**	0.4	»	**38**	47	15	»	0.5
III ..	13.004	36	**14.3**	**54**	46	**27**	16	11	27	10	**9**	0.2	»	**30**	**53**	17	»	0.1
IV ..	10.140	**39**	13.2	47	**53**	23	14	10	31	12	**10**	0.1	»	18	**53**	**28**	1	1
V ..	7.136	32	11.1	47	**53**	**26**	13	7	40	12	2	»	»	24	31	**40**	5	0.5
VI ..	7.096	19	7.9	**53**	47	20	20	13	35	12	1	.	»	**25**	11	**56**	8	»
VII ..	1.536	5	1.8	20	**80**	7	4	10	33	**48**	»	»	»	2	17	**68**	**14**	»

temperate zones, to the south of, or below, the 20 per cent Ch biochore.

The A group was again divided into 3 minor groups according to the temperature requirements of the groups.

The A 1 group requires the highest temperature and is only found in subarctic regions. 66° N. lat. in West Greenland was chosen as a practical northern limit.

The A 2 group does not require so high a temperature, yet it does not occur in the most pronouncedly arctic regions. The northern limit of the group in West Greenland lies south of 76° N. lat.

The A 3 group is of common occurrence as far north as northern Greenland, hence it is the group that thrives best in the most extreme cold.

While cold, i. e. a low temperature, together with a varying amount of heat is indispensable for the A groups, heat is indispensable to the E group. In the latter group we may likewise distinguish a series of types according to their temperature requirements. Hence group E was divided into 4 minor groups of which E 1 required most heat, E 4 least.

The species of the E 1 group have their northern limit in Scandinavia that is to say, they belong to southern Scandinavia.

The E 2 group has no northern limit in Scandinavia, but does not occur in Greenland.

The E 3 group is composed of Icelandic species which occur in Greenland, but south of 66° N. lat.

The E 4 group occurs in Greenland north of this line.

The distribution of the species groups in the various parts of Iceland as well as in the Icelandic altitudinal zones fully confirms the above described distribution of the groups, both as regards quantity and as regards mere presence. Thus the A group occurs most abundantly and with the greatest number of species in the north and in the highland tracts, whereas the E group is the dominant group in the lowlands and the south country.

Of the A sub-groups A 1 prefers the lowland, A 2 the lower tracts of the highland, and A 3 the upper tracts of the highland.

Of the E sub-groups E 4 is of common occurrence everywhere, though there is an appreciable decrease in the upper tracts of the highlands. E 3 occurs most frequently in the lowlands. E 2 and especially E 1 occurs solely, and only in scattered specimens, in the

lowlands. These plants find the most favourable conditions of growth round the hot springs.

The circling investigations closely confirm these results. The A percentage of the formations is higher in the highland than in lowland tracts, and higher in North Iceland than in South Iceland. The same applies to the sub-groups, A 1 showing a steady decrease in quantity from the lowlands to the highlands: at Bjørk and Lækjamót the average A 1 percentages are 12.1, at Lýngdalur the A 1 percentage is 9.1, and at Arnarvatnsheiði it is 5.8.

A 2 occurs more frequently in the highlands than in the lowlands, and more frequently in North Iceland than in South Iceland, this is the case too with A 3, only in an even more marked degree.

The E sub-groups show similar relations. E 4 occurs with equal frequency in the highland and lowland tracts. E 3 occurs most frequently in the lowlands, especially in the south country. The same applies in even greater degree to E 2 and especially to E 1.

Table 26 shows the numerical values and their variations according to altitude and district.

Table 26 shows the distribution of the species groups in the scale of moisture.

The A group shows the same depression on moderately moist soil as the chamaephytes; from Zone IV the A percentage shows an increase, both upwards in the mo and downwards in the mýri. In Zone VII, the flói, the A percentage reaches its lowest value.

The individual sub-groups show different relations; while the A 3 group decreases steadily as we pass downwards in the scale from mo through jaðar to mýri, the reverse is the case with the two other groups, so that the increase of A in the lower section must be ascribed to A 2 and A 1. These relations are most plainly illustrated in the lowland series: Bjørk, Lýngdalur, and Lækjamót.

The individual sub-groups of E play a very different part in the composition of the vegetation. E 4 occurs in the greatest quantity, then successively E 3, E 2, and E 1.

While E 4 and especially E 3 must be said to prefer the damper section of the scale, the reverse is the case with E 2 and E 1 which only occur in the mo formations. In the Lækjamót series, however, E 2 forms an exception to this rule, for, similarly to E 4 and E 3, this group increases with increasing moisture of the soil.

Even if the 7 sub-groups cannot perhaps be said to form a continuous scale of adaptation to decreasing temperature, this is at

any rate the case within the sub-groups of each of the two larger groups, and this justifies a linear grouping like the one employed. If now we regard the spectra of the scale of moisture as a whole, as a series-spectrum, it shows a pronounced tendency to form a wedge downwards, produced by a decrease in quantity of the sub-groups of both main groups from without inwards. This wedge shape appears in all the series.

The wedge shape of the series-spectrum must be put down to the different temperature conditions in the different sections of the scale.

Thus the variations in temperature in the upper part of the scale will be greater than in the lower part since the specific heat of the water will act as a buffer here against changes of temperature. To this must be added the fact that considerably more water will evaporate from the damper than from the drier areas, and since the temperature at which water evaporates, as well as its specific heat, is very high, this will in practice mean a slower and slighter heating of a moist than of a dry area. In the summer, therefore, the temperature will be lower in the former than in the latter area. In the winter the reverse will be the case. If, in addition, the temperature drops below zero, considerable amounts of heat will be liberated within the moist areas, viz. the heat which has become latent by the thawing of the ice, the effect of which will be that a damp soil will freeze slower and not to such depths as a dry soil.

In the case of moderately moist soil, one more circumstance must be noted. This zone is relatively dry in the summer, and relatively moist in the winter, which gives it more or less the advantages of dry soil in the summer and of wet soil in the winter. All in all this area will have more favourable temperature conditions than the areas above and below.

The interaction of temperature conditions and vegetation in the various zones of moisture will thus be as follows: —

A. Melar (Zone I) is in pronounced degree cold in the winter as well as warm in the summer. Hence plants which require much cold (Ch and A 3 species) and much heat (E 2+1 species) thrive well here. In contrast to the other zones of moisture it is, however, bare of snow in the winter. This will further encourage the A 3 species, while the E 2+1 species will decrease in quantity.

B. The Mo (Zones II—III) is likewise cold in winter and warm

in summer, though in less degree than Zone I. Hence the same types of plants occur here.

C. Jaðar (Zone IV). As previously indicated, this zone must be regarded as relatively warm in winter and warm in summer, owing to the variations in the level of ground-water. Hence the result is that the vegetation consists in marked degree of southern types, H, Th, and E species.

D. Mýri (Zones V—VI) is warm in the winter but cold in the summer. Hence southern plants requiring much heat (E 2+1 species) and northern plants requiring much cold (A 3 species) thrive badly or are unable to thrive here. As a matter of fact the vegetation consists of southern plants requiring little heat (E 4+3 species) and northern plants requiring little cold (A 2+1 species).

E. Flói (Zone VII). Here the vegetation is covered by so deep a layer of water that the frost hardly reaches it in the winter. Hence it is never exposed to the conditions required by arctic plants; consequently these are absent at any rate in the lowlands and as compared with the mýri formations. In the summer, too, the vegetation is covered by water. The heat which benefits the plants on drier soils is latent in the water here. The result is a relatively low temperature which excludes the southern plants requiring more heat. Hence the species group spectrum is compressed to the central parts of the spectrum.

Between halla mýri and fór mýri there is a peculiar difference in regard to the species group spectrum.

As previously mentioned, the difference between the halla mýri and the fór mýri is this, that halla mýri appears where the ground water comes to the surface, while the fór mýri is dependent for its moisture on the surface precipitation water. While the temperature of the water is to a certain extent dependent on the temperature of the air in the latter case, the temperature of the water in the halla mýri is dependent on that of the ground-water, which again is equal to the annual mean temperature of the locality in question. In the winter there will be a constantly varying amount of relatively warm water in the halla mýri to be cooled, whereas, in the fór mýri, there will be a constant amount of water to be cooled, and the result must be that the temperature of the halla mýri in the winter must be higher than that of the fór mýri. In the summer the reverse must be the case. The heat in the halla mýri will have a constantly varying amount of

now relatively cold water to heat, while in the fór mýri there will be a constant amount of water to be heated, and the result will be that in the summer the temperature of the fór mýri will be higher than that of the halla mýri. Which will be best for the vegetation must depend on the relative lengths of summer and winter. Where summer is the longer season, the result will be a relative cooling of the locality in question and a stronger cooling than that which is conditioned by stagnant water. Where winter is the longer season, the locality in question will offer favourable temperature conditions for the vegetation, even though the summer, short as it is, must also exert its influence.

The former conditions prevail in Denmark, the latter in Iceland. For Denmark A. Mentz (1912) has shown that the Paludella bog is tenanted by a series of northern-alpine species not found elsewhere in this country. Thus the Paludella bog offers more favourable growth conditions to arctic plants than other types of bogs. The same is the case in Iceland. In the halla mýri at Lækjamót the quantity of A 2 species is considerably higher than in the corresponding fór mýri zones in the south country, while the quantity of A 2 + A 1 species is higher in the halla mýri of the valley slopes than in the fór mýri of the valley bottom.

Hence the cold water peculiar to the halla mýri in the summer has even in Iceland a noticeable influence on the vegetation and gives it an arctic character.

The effect on the vegetation of the warm water in winter is, however, much stronger.

If, in a fór mýri series, we pass from the drier to the more moist zones, the E 3 percentage has practically the same value throughout the zones until we reach the very wettest, when it shows a very great rise. In the halla mýri series the E 3 percentage has its lowest value in the drier zones, whence it rises steadily until it attains its highest value in the dampest zone.

In the fór mýri series E 2 attains its highest value in the driest to moderately moist zones (mo and jaðar), whereas, in the dampest zones (mýri and flói), it has decreased much or is entirely absent. In the halla mýri, on the other hand, the E 2 percentage rises on the passage from dry to moist soil: where there is the highest degree of moisture, the E 2 percentage is highest.

This difference between the halla mýri and the fór mýri is most naturally explained if we assume that it is

TABLE 27. **The Distribution of the Species in the Scale of Moisture.**

	Average							Bjork c. 100 m. o. H.							Lýngdalur							Arnarvatnsheiði						
	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII	I	II	III	IV	V	VI	VII
Arctostaphylos uva ursi	0.3	**31**	1	»	»	»	»	1	93	3	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»
Calluna vulgaris	1.3	**29**	**28**	2	»	»	»	4	85	85	6	»	»	»	»	2	»	»	»	»	»	»	»	»	»	»	»	»
Thymus serpyllum	**53**	**50**	32	4	»	»	»	80	84	69	10	»	»	»	29	58	16	»	»	»	»	49	8	11	1	»	»	»
Agrostis canina	47	**64**	**77**	39	20	0.3	»	95	96	91	40	32	»	»	46	89	100	72	28	1	»	»	8	40	6	»	»	»
Selaginella selaginoides	14	34	**63**	20	5	2	»	40	17	43	34	12	4	»	2	66	80	20	4	3	»	»	18	66	5	»	»	»
Galium boreale	10	**44**	**43**	28	9	2	»	26	60	48	44	12	6	»	3	73	80	40	16	»	»	»	»	»	»	»	»	»
— verum	**7**	5	3	1	»	»	»	20	4	8	4	»	»	»	1	10	»	»	»	»	»	»	»	»	»	»	»	»
Deschampsia flexuosa	8	**39**	**34**	6	»	»	»	18	53	37	8	»	»	»	6	64	60	»	»	»	»	»	»	6	10	»	»	»
Anthoxanthum odoratum	4	**9**	4	1	»	»	»	11	12	4	»	»	»	»	»	14	8	»	»	»	»	»	»	»	2	»	»	»
Luzula multiflora	1.7	6	**8**	**10**	2	»	»	5	15	9	10	6	»	»	»	2	16	16	»	»	»	»	»	»	3	»	»	»
Equisetum pratense	6	**28**	**29**	11	»	»	»	18	35	60	18	»	»	»	»	50	28	8	»	»	»	»	»	»	6	»	»	»
Taraxacum officinale	0.3	1.3	9	**18**	1.3	»	»	1	3	15	22	4	»	»	»	1	12	»	»	»	»	»	»	»	33	»	»	»
Deschampsia caespitosa	»	0.3	16	**41**	3	»	»	»	»	19	58	6	»	»	»	1	28	64	4	»	»	»	»	»	»	»	»	»
Agrostis tenuis	»	2	6	**23**	1.3	»	»	»	1	19	70	4	»	»	»	5	»	»	»	»	»	»	»	»	1	»	»	»
Carex sparsiflora	»	3	**11**	**10**	»	»	»	»	7	20	18	»	»	»	»	1	12	12	»	»	»	»	»	»	»	»	»	»
Salix lanata	»	»	»	»	»	»	»	2	5	24	52	68	2	»	»	»	8	»	8	»	»	»	1	»	3	»	»	»
Viola palustris	»	1	9	**31**	**40**	2	»	»	»	7	48	76	6	»	»	3	20	36	44	»	»	»	»	»	9	»	»	»
Comarum palustre	»	»	»	9	**44**	19	1	»	»	»	16	74	42	2	»	»	»	12	56	15	»	»	»	»	»	1	»	»
Carex Goodenoughii	»	»	0.3	47	**67**	**66**	53	»	»	»	54	100	100	66	»	»	»	88	100	97	68	»	»	1	»	»	»	25
— chordorrhiza	»	»	»	3.3	49	**80**	20	»	»	»	6	42	96	50	»	»	»	4	100	95	2	»	»	»	»	5	48	7
— rostrata	»	»	»	1.3	9	**34**	20	»	»	»	4	20	36	50	»	»	»	»	4	44	»	»	»	»	»	3	21	9
Menyanthes trifoliata	»	»	»	»	3	**11**	1	»	»	»	»	10	28	2	»	»	»	»	»	4	»	»	»	»	»	»	»	»
Juncus trifidus	**41**	**45**	**51**	6	1	»	»	45	40	48	6	»	»	»	36	56	56	4	»	»	»	43	40	48	7	1	»	»
Luzula spicata	**44**	**44**	**43**	14	3	1	»	37	37	19	12	»	»	»	26	50	48	»	»	1	»	69	44	62	31	10	»	»
Galium Normanni	35	**49**	**55**	34	7	»	»	88	53	53	42	8	»	»	13	77	76	24	12	»	»	4	18	37	36	1	»	»
Elyna Bellardi	21	22	**30**	3	1	»	»	53	12	45	4	»	»	»	3	22	»	»	»	»	»	6	32	45	6	1	»	»
Trisetum spicatum	11	18	**22**	5	2	1	»	22	7	11	2	2	2	»	3	35	28	12	4	1	»	7	11	27	1	1	»	»
Thalictrum alpinum	15	48	**69**	**87**	55	22	»	39	43	65	80	62	18	»	»	26	64	96	80	48	»	5	76	88	86	23	»	»
— ovina	[illegible]	88	93	87	60	13	»	97	95	99	98	84	11	»	15	93	92	96	92	25	»	11	77	88	66	5	»	»

[illegible]	»	94	97	[illegible]	[illegible]	19		90	100	100	[illegible]	56	56		48	88	99	98	91	61		[illegible]	[illegible]	[illegible]	[illegible]			
															13	71	61	20	15	10		59	86	87	58	76	9	4
Carex rigida	29	68	**81**	**80**	41	11	»	85	71	77	42	6			2	86	96	100	60	33		»	47	70	97	56	»	»
Polygonum viviparum	68	**87**	**95**	**93**	**95**	**86**	4	65	76	92	92	91	80		62	86	96	96	92	93		78	98	96	91	98	86	11
Pinguicula vulgaris	2	5	5	0.3	1.3	3	»		3	5		4	8		2	8	»		»	7		3	4	9	1			»
Vaccinium uliginosum	7	**57**	44	26	47	**64**	»	8	80	49	66	78	94		8	14	12	4	24	92		4	76	72	7	39	7	
Betula nana	»	**15**	1	1	8	**53**	»	»	»	»	»	14	90					»	8	70			45	1	2	3		»
Equisetum variegatum	8	17	**36**	**32**	**26**	4	4	20	19	19	18	28			1	15	12	40	8		»	2	18	76	37	43	11	13
arvense	4	10	22	**55**	34	1	»	10		16	40	38		»	»	4	12	48	16	»	»	1	26	38	78	47	4	
Cardamine pratensis	4	11	41	**59**	38	10	1	13	8	64	70	40	12	»	»	26	48	48	24	4	»	»		10	60	50	13	1
Eriophorum polystachyum	»	»	»	27	**78**	**81**	37				18	86	90	12		»		48	68	71	»	»			14	79	81	100
Carex rariflora	»	»	1	10	**53**	**48**	10	»	»	1	2	70	54	6				28	88	91	»		»	1				25
Cerastium alpinum	**25**	8	5	9	»	»	»	13		7	»	»	»	»	18	14	»		»	»		43	10	9	28		»	
Dryas octopetala	**21**	9	9	»	»	»	»		»	»		»	»		21	»	»			»		41	26	26			»	
Poa glauca	**18**	8	5	3	»	»	»	7		1	»	»	»	»	3	17	4	»	»	»		45	6	10	9			
Silene acaulis	**33**	**32**	28	6	»	»	»	20	7	9		»			15	26	24				»	65	63	50	17			
Armeria vulgaris	8	8	7	5	0.3	»	»	1	»	1			»		16	2	»	»	»	»	»	7	22	20	14	1	»	
Bartschia alpina	1	2.3	**11**	1.7	0.3	»	»	»	1	»	»	»	»		2	»	»	»		»	»	1	6	33	5	1	»	
Tofieldia palustris	1.3	4	**6**	0.7	»	0.7	»	»	»	»	»		2	»	2	1						2	11	17	2			
Salix glauca	»	»	»	»	»	»	»	1	»		12	24	4	»	»	»	»				»	8	55	37	43	60	41	7
Cassiope hypnoides	8	6	**13**	»	»	»	»	»					»		11				»			13	18	40				»
Loiseleuria procumbens	9	2	7	»	»	»	»	»		»		»	»		26	»	»	»	»	»	»	1	6	22				»
Poa alpina	2.7	3	**10**	**12**	2	0.3	»	»		»	»				»	1	»	8		»	»	8	8	30	27	6	1	»
Rumex acetosa	0.7	2.3	7	**13**	0.7	»	»	»	»	7	2	»			2	6	»	»		»	»	»	1	15	37	2		»
Deschampsia alpina	0.7	»	0.3	**11**	»	»	»	»	»	»	»	»		»	2	»	»	4	»	»	»	»	»	1	29			»
Carex alpina	»	»	»	**5**	2	»	»	»	»		»	»		»	»	»		12	»			»		»	3	6		»
— dioica	»	»	0.3	2	**17**	2.3	»	»	»	»		»	»	»	»	»	»	4	4	1		»		1	2	47	6	»
— saxatilis	»	»	»	»	**2**	1.7	3		»	»	»	»		»	»	»	»	»	»		»	»		»	»	6	5	2
Arenaria ciliata	**1**	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	»	3				»	»	
Saxifraga cæspitosa	**4**	»	»	»	»	»	»		»	»	»		»		»				»	»		13			»			
— oppositifolia	**2.3**	»	»	»	»	»	»	»			»	»			»							7						
Luzula arcuata	**6**	»	0.3	»	»	»	»			»				»	5	»	»	»		»	»	12		1				
Arabis petræa	**16**	»	»	»	»	»	»		»	»	»		»	»	11	»			»			36	»		»			
Minuartia verna	**11**	3	1.3	»	»	»	»	»						»		»			»	»		34	9	4		»		
Viscaria alpina	2	**4**	**5**	1	»	»	»	»			»	»	»	»	»	»	»	»	»	»	»	6	13	14	1			»
Pedicularis flammea	0.3	1.3	**1**	**1**	0.3	»	»			»			»	»	»	»			»	»		1	4	3	3	1		
Saxifraga Hirculus	»	0.3	**1**	2	**4**	»	»	»		»			»	»	»			»	»		»	»	1	3	6	12		

the result of the effect on the halla mýri of the warm water in the winter.

The Distribution of the Species in the Scale of Moisture.

Table 27 shows the distribution of the species in the scale of moisture respectively at Bjørk, on Lýngdalsheiði, and on Arnarvatnsheiði. A special column further shows the average values for these three localities.

The Lækjamót series has not been included in the table since the mýri formations here differ in several respects from the above mentioned, thus causing some deviations which are not due to the conditions of moisture. On the whole, however, the distribution of the species in the scale of moisture in the Lækjamot series confirms the relations stated below.

In order to facilitate a general view the species have been grouped according as they occur with the greater frequency in the lowland formations or in the highland formations, or with equal frequency in both. Within each of these groups the species have then been arranged with the least »moisture-loving« first and the most »moisture-loving« last. Considerations of space have, however, necessitated the exclusion of some more rarely occurring species.

The figure marked against a given species in a column is the average F.-percentage of the species in question for the zone of moisture of the locality in question. Thus in the Elyna mo at Bjørk, Festuca rubra has the frequency percentages 96, 96, 100, and 96 in the 4 localities there examined. The sum, 388, divided by the number of the localities, 4, makes 97, which is the figure marked against Festuca rubra in table 27, Bjørk I.

If, next, we consider the distribution of the species in the scale of moisture, it is an extremely variegated picture that meets the eye both as regards quantitative distribution, that is to say, the average distance of the individuals, and as regards the mode of distribution in the scale. Some species show a low F.-percentage (i. e. a great average distance between the individuals), others a high F.-percentage (i. e. a small average distance between the individuals). Some species occur only in a small number of moisture classes, others in a larger number or in all classes. Some species only occur in the dry classes, others only in the moderately moist, others again only in the moist etc. But to whichever class or classes a

species belongs, it applies to all species that there is one class of moisture in which the species attains its highest F.-percentage and shortest distance between the individuals, and outside which the F.-percentage decreases and the distance between the individuals increases whether we go up or down the scale of moisture.

The distribution of the species in the scale may afford ground for the setting up of a series of types characterised by the magnitude of the F.-percentage, the position of the maximum in the scale, the number of classes in which the species occurs etc. etc., and in time it will be necessary to introduce a terminology in order to characterise briefly the relations of a species within an area. At the present time, while such investigations are still in their inception, there is no reason to set up such a system, especially since a good deal of material would be requisite for such a purpose. This part of the investigation must therefore be left until a later period. In this connection it will suffice, as was the main object of our investigation, to establish the fact that a species is closely identified with a definite degree of moisture of the soil. If there is any change in the degree of moisture, no matter in what direction, the F.-percentage of the species will change simultaneously, and the greater the change in the degree of moisture, the greater, too, will be the change in the F.-percentage, until such conditions of moisture are reached as entirely exclude the species. The species reacts identically to changes in moisture wherever it occurs.

The table shows how markedly this is the case in the three localities Bjørk, Lýngdalur, and Arnarvatnsheiði therein indicated. These three localities have been selected at random from the areas of distribution of the species discussed, and there is no reason to suppose that an investigation in other localities under the same external conditions would give a picture of the relation of the species concerned to the degree of moisture essentially different from that shown in the table. Greater certainty might of course be gained by an increased number of investigations, in that the influence on the magnitude of the F.-percentage of accidental factors, i. e. factors not determined by the degree of moisture, would be precluded or diminished.

The distribution of a species in a scale of external factors is just as constant and »good« a character in a species as any morphological or anatomical character.

TABLE 28.

A, B, C and D denote the different series of types of moisture (cf. text).

	I	II	III	IV	V	VI	VII
A. Minuartia verna	**16**	»	»	»	»	»	»
Thymus serpyllum	**53**	**50**	32	4	»	»	»
Juncus trifidus	41	**45**	**51**	6	1	»	»
Selaginella selaginoides	14	34	**63**	20	5	2	»
Cardamine pratensis	4	11	41	**59**	38	10	1
Viola palustris	»	1	9	31	**40**	2	»
Carex Goodenoughii	»	»	1	47	**67**	**66**	53
* Eriophorum polystachyum	»	»	»	14	79	81	**100**
* Carex rostrata	»	»	»	4	20	36	**50**
B. Poa alpina	3	3	10	12	2	1	»
Equisetum variegatum	8	17	36	32	26	4	4
Polygonum viviparum	**68**	**87**	**95**	**93**	**95**	**86**	4
C. Cardamine pratensis	4	11	**41**	**59**	**38**	10	1
Deschampsia cæspitosa	»	1	16	**41**	3	»	»
* Carex capitata	»	»	»	8	»	»	»
D. Empetrum nigrum	»	**94**	**97**	42	**52**	**49**	»
Vaccinium uliginosum	»	**57**	**44**	26	**47**	**64**	»
Betula nana	»	**15**	1	1	8	**53**	»

In considering the ecology of a species, a knowledge of both groups of characters is equally necessary.

Table 28 shows a selection of types of moisture differing in respect of position and magnitude of the maximum and the number of classes over which the species is distributed. A number of deviating species are given at last.

A. The individual species in the series *Minuartia verna, Thymus serpyllum* . . . . (the A series) are characterised by a pronounced maximum differently situated for the different species and at different levels. From the maximum class the F.-percentage decreases equally in both directions or from the edge of the scale towards its middle.

B. *Poa alpina, Equisetum variegatum,* and *Polygonum viviparum* differ from the above species in that they are equally distributed over all classes of moisture; they differ from each other by the F percentage which is low for *Poa alpina,* somewhat higher for

Equisetum variegatum and very high for *Polygonum viviparum*, corresponding to a dense growth of *Polygonum viviparum*, a somewhat more scattered growth of *Equisetum variegatum*, and a very scattered growth of *Poa alpina*.

C. A third series is represented by *Cardamine pratensis*, *Deschampsia cæspitosa*, and *Carex capitata*. These species all have their maximum frequency percentage in class IV; they differ from each other in the magnitude of the F.-percentage. For *Cardamine pratensis* the F percentage is 59, for *Deschampsia cæspitosa* it is 41, and for *Carex capitata* 8. They also differ in the number of classes over which they are distributed: *Cardamine pratensis* occurs in all classes of moisture, I—VII, *Deschampsia cæspitosa* in classes II—V, and *Carex capitata* only in class IV.

D. Most Icelandic species show the above-mentioned regular distribution in the scale of moisture. A small number of species deviate in that they have two maxima with an intermediate relative minimum. These species are represented by *Empetrum nigrum*, *Vaccinium uliginosum*, and *Betula nana*. In a previous section on the distribution of the chamaephytes in the scale of moisture we attempted to explain these facts. The relative minimum is due to annual variations in the water level.

Scale of Snow-Covering. Distribution of Species, Species-Groups, and Life-Forms in the Same.

For the present it is not possible to set up a scale of snow-covering as minutely graduated as the scale of moisture. The reason is that so far the depth and duration of the snow-covering have not been investigated. In the individual localities it is easy enough to observe the effect on the vegetation of the different depths of the snow-covering, but comparisons between the various localities are rendered difficult by the fact that we have no exact particulars on which to base a comparison between the scales of snow-covering of the different localities. According to Thoroddsen (1914) the snow lies longer and is of greater depth in the north country than in the south-west, and in the south country there may be no snow at all during a long period. In the highland tracts the depth and duration of the snow-covering is greater than in the lowlands. These facts must be taken into consideration in a comparison between the differences in vegetation at the various stations.

Under the treatment of the formations in the various localities examined, the causes of the differences in vegetation have been more precisely stated. At Bjork in the south country the difference between the Elyna mo and the Arctostaphylos mo was caused, amongst other things, by a difference in the depth of the snow-covering. The Elyna mo has a relatively thin covering of snow, that of the Arctostaphylos mo is somewhat deeper. However, the difference is not considerable enough to cause the appearance of two different types of vegegation. At Norðtunga in the south-west country mo and forest-ground are covered by snow of different depths; while the mo has the snow-covering normally occurring in that part of the country, the forest-ground is covered by a considerable layer of snow throughout the winter. At Lækjamót in the north country, the mo has likewise the normal snow-covering, whereas the melar is bare of snow. All these localities are lowland localities situated at c. 50—100 m above sea-level. If we pass from the lowlands to the highlands, the difference in the scale of snow-covering will become increasingly evident. At Lýngdalur in the south country (c. 250 m above sea-level), three types of vegetation are easily distinguished. The difference between these three types, mosathembur and melar with little or no snow-covering, mo with a normal snow-covering, and geiri with a deep and constant snow-covering, is due to the difference in the snow-covering. In some places a transitional form between mo and mosathembur had developed, with an intermediate depth of snow.

At Thrasaborgir (c. 400 m above sea-level) the three types mosathembur, mo and geiri were likewise devoloped.

On Arnarvatnsheiði near Úlfsvatn at an altitude of c. 500 m above sea-level, the scale of snow-covering was further differentiated. The 5 types of vegetation, melar, Betula-nana mo, the knolly mo, the sides of the snow patches, and the bottoms and north sides of the snow patches, represent 5 different degrees of snow-covering, where the first type has the slightest snow-covering of the shortest duration, the last, the deepest snow-covering of the longest duration,

Table 29 gives the distribution of the species in the scales of snow-covering of the 6 localities mentioned above. Within each locality the formation most devoid of snow is given first, furthest to the left, while the formation with the deepest snow-covering is put last, furthest to the right. Bjørk a is the Elyna mo, Bjørk b

the Arctostaphylos mo. Lýngdalur a, b, c, d, and e are respectively mosathembur, melar, transitional forms between mosathembur and mo, mo and geiri. Thrasaborgir a, b, and c are respectively mosathembur, mo and geiri. Lækjamót a and b are melar and the high mo. Norðtunga a, b, and c are the mo, the vegetation in the forest glades, and the vegetation on the forest-ground. Arnarvatnsheiði a, b, c, d, and e are respectively melar, Betula-nana mo, the knolly mo, the vegetation on the sides of the snow patches, and the vegetation on the bottom of the snow patches with a northern exposure.

A comparison of the mean values has been attempted and is likewise given in the table. The scale is divided into three divisions. I represents the types of vegetation bare of snow, melar (I b), and mosathembur (I a). II represente types with normal snow-covering, viz. the mo. III represents types of vegetation with a constant snow-covering, i. e. geiri and forest. In the calculation of the mean values the deviating localities have been omitted, viz. Bjørk a and b, Lýngdalur c, and Norðtunga c. The figures under I a are thus the mean values of Lýngdalur a and Thrasaborgir a; I b the mean values of Lýngdalur b, Lækjamót a, and Arnarvatnsheiði a. II represents Lýngdalur d, Thrasaborgir b, Lækjamót b, Norðtunga a, and Arnarvatnsheiði b and c. III, finally, represents the mean values of Lýngdalur e, Thrasaborgir c, Norðtunga b, and Arnarvatnsheiði d and e.

The distribution of species in the scale of snow-covering is as the distribution of species in the scale of moisture. Some species attain their maximum F.-percentage in class I, others in class II, others again in class III. Some species have a high frequency percentage in one of the classes, others in two classes, either I and II or II and III; only a small number of species occur with a high frequency percentage in all classes.

A comparison between the different scales of snow-covering shows in what uniform proportions the species occur in the different localities. It may be laid down as a main rule that the species react uniformly to the same changes in respect of snow-covering. A species which, in one locality, attains its maximum F.-percentage where there is a normal snow-covering but decreases if the snow-covering changes no matter in what way, will behave in the same way in all the other localities.

TABLE 29. **The Distribution of the Species i**

	Average			Bjørk		Lyn	
	I b (I a)	II	III	a	b	a	b
Saxifraga caespitosa	4	»	»	»	»	»	»
Arenaria ciliata	5	»	»	»	»	»	»
Luzula arcuata	6	+	»	»	»	»	5
Saxifraga oppositifolia	14	»	»	»	»	»	»
Arabis petræa	18	»	»	»	»	»	11
Minuartia verna	19	2	»	»	»	»	»
Poa glauca	30	10	+	7	»	»	3
Dryas octopetala	31	23	»	»	»	»	21
Cerastium alpinum	37 (3)	11	»	13	»	5	18
Silene acaulis	45 (6)	43	+	20	7	3	15
Luzula spicata	47 (2)	47	1	37	37	2	26
Thymus serpyllum	44	42	6	80	84	»	29
Festuca ovina	48 (2)	32	9	38	77	1	42
Carex rigida	1 (66)	69	73	85	71	92	2
Salix herbacea	37 (55)	79	66	51	60	14	45
Polygonum viviparum	58 (23)	90	53	65	76	14	62
Empetrum nigrum	22 (5)	86	73	90	100	2	38
Festuca rubra	26 (27)	89	65	97	95	48	45
Thalictrum alpinum	10 (25)	71	38	39	43	41	»
Galium Normanni	14 (3)	51	23	88	53	5	13
Juncus trifidus	29 (3)	50	8	45	40	1	36
Elyna Bellardi	7	45	4	53	12	»	3
Selaginella selaginoides	4	45	14	40	17	»	2
Equisetum variegatum	2 (2)	28	5	20	19	3	1
— pratense	1 (5)	23	5	18	35	10	»
Trisetum spicatum	7	18	2	22	7	»	3
Cardamine pratensis	1	11	5	13	8	»	»
Galium boreale	1	37	48	26	60	»	3
Equisetum arvense	1	20	20	10	»	»	»
Agrostis canina	18 (1)	67	75	95	96	1	46
Salix glauca	3	19	30	1	»	»	2
Deschampsia flexuosa	2	25	90	18	53	»	6
Vaccinium uliginosum	4 (+)	54	75	8	80	»	8
Viola palustris	»	1	25	»	»	»	»
Geranium silvaticum	»	+	25	»	»	»	»
Agrostis tenuis	»	3	23	»	1	»	»
Galium verum	+	2	20	20	4	»	1
Gnaphalium supinum	»	1	19	»	»	»	»
Taraxacum officinale	»	+	18	1	3	»	»
Calluna vulgaris	»	1	12	4	85	»	»
Sibbaldia procumbens	»	»	12	»	»	»	»
Rumex acetosa	1	6	12	»	»	1	2
Luzula multiflora	»	6	10	5	15	»	»
Hierochloë odorata	»	»	9	»	»	»	»
Vaccinium Myrtillus	»	»	7	»	»	»	»
Alchemilla alpina	1	»	4	»	»	»	2
Leontodon autumnalis	»	»	6	»	»	»	»
Alchemilla minor	»	»	5	»	»	»	»
Rubus saxatilis	»	»	2	»	»	»	»

e of **Snow-Covering** (cfr. the text).

	Thrasaborgir			Lækjamót		Norðtunga			Arnavatnsheiði				
e	a	b	c	a	b	a	b	c	a	b	c	d	e
»	»	»	»	»	»	»	»	»	13	»	»	»	»
»	»	»	»	11	»	»	»	»	3	»	»	»	»
»	»	»	»	»	»	»	»	»	12	»	1	»	»
»	»	»	»	35	»	»	»	»	7	»	»	»	»
»	»	»	»	8	»	»	»	»	36	»	»	»	»
»	»	»	»	23	»	»	»	»	34	9	4	»	»
»	»	»	»	43	24	»	»	10	45	6	10	1	»
»	»	»	»	30	84	»	»	»	41	26	26	»	»
»	1	2	»	50	28	4	»	2	43	10	9	»	»
»	9	22	»	54	62	32	»	»	65	63	50	1	»
1	2	24	»	47	62	48	2	»	69	44	62	3	»
15	»	»	»	54	88	88	9	»	49	8	11	4	»
1	2	6	2	46	30	64	38	10	57	42	12	»	2
54	40	82	74	1	54	72	70	60	»	47	70	84	84
38	96	96	96	8	66	64	7	»	59	86	87	88	100
28	31	88	54	33	98	76	61	24	78	98	96	68	54
97	7	60	72	1	92	84	72	16	28	93	98	75	50
68	5	86	74	32	92	96	83	48	11	77	88	39	62
5	9	60	12	24	94	80	78	60	5	76	88	93	»
30	»	58	4	26	46	68	53	20	4	18	37	28	»
8	4	42	»	9	52	60	27	6	43	40	48	5	»
2	»	»	»	12	86	84	15	»	6	32	45	1	»
12	»	30	24	9	56	40	5	»	»	18	66	29	»
»	»	28	»	3	30	»	»	»	2	18	76	8	16
16	»	»	»	3	38	52	9	18	»	»	»	»	»
2	»	»	»	12	20	16	6	»	7	11	27	»	»
24	»	»	»	3	38	»	»	»	»	»	10	1	»
85	»	74	76	»	»	72	78	40	»	»	»	»	»
1	»	6	2	3	30	16	3	»	1	26	38	28	66
71	»	92	88	8	80	92	72	60	»	8	40	55	88
2	»	»	2	»	18	»	»	»	8	55	37	55	88
99	»	64	98	»	»	16	80	98	»	»	6	97	74
99	1	4	58	»	68	88	85	30	4	76	72	85	50
21	»	»	48	»	»	»	8	2	»	»	»	24	26
17	»	»	8	»	»	»	5	»	»	»	»	93	2
45	»	2	30	»	»	12	19	18	»	»	»	21	»
15	»	2	2	»	»	»	53	8	»	»	»	31	»
»	»	4	50	»	»	»	»	»	»	»	»	8	36
23	»	»	10	»	»	»	8	2	»	»	»	20	30
59	»	»	»	»	»	»	»	»	»	»	»	»	»
»	»	»	28	»	»	»	»	»	»	»	»	12	22
»	»	2	»	»	8	4	1	8	»	1	15	27	34
15	»	»	2	»	20	12	32	8	»	»	»	»	»
»	»	»	»	»	»	»	1	»	»	»	»	28	16
30	»	»	6	»	»	»	»	»	»	»	»	»	»
»	»	»	14	»	»	»	»	»	»	»	»	7	»
4	»	»	4	»	»	»	15	2	»	»	»	»	6
4	»	»	8	»	»	»	»	»	»	»	»	13	»
5	»	»	4	»	»	»	1	»	»	»	»	»	»

There are, however, a few interesting deviations from the rule.

Thus *Calluna vulgaris* is of common occurrence in the mo at Bjørk. At Lýngdalur it is absent, or practically absent from the mo, whereas it occurs very abundantly in the snow patches. At Thrasaborgir it occurs neither in the mo nor the geiri.

Deschampsia flexuosa occurs both in the mo and the geiri in the south country; in the south-west, the north, and the highland tracts it is either entirely absent or occurs only in scattered growth in the mo, whereas it is very abundant in the geiri (and forest).

Thalictrum alpinum is a mo plant in the south country but shuns geiri; in the south-west and north country it is still a mo plant, but here it is also met with in the more snow-covered types of vegetation as forest and geiri.

It seems natural to suppose that these deviations are due to differences in temperature.

Vaccinium uliginosum is another interesting example. Its F.-percentage varies as follows in the scale of snow-covering. In I a (mosathembur) it has an average F.-percentage of 0.5, in I b (melar) 4. Class II, i. e. the mo, has an average F.-percentage of 54 and class III 75. The species is thus a pronounced geiri plant though with strong tendencies towards the mo. At Bjørk it plays a prominent part in the mo, especially the Arctostaphylos mo, while the Elyna mo is less favourable. In the mo at Lýngdalur it is but sparsely represented, while it is dominant in geiri. The same applies at Thrasaborgir. In the highland tracts, at Lækjamót and Norðtunga, it is not only peculiar to the areas with a deep snow-covering, it also occurs with a high F.-percentage in the mo. On melar it does not occur, however.

These peculiarities must no doubt be put down to differences in the scale of snow-covering between the south country on the one hand and the rest of the country on the other. In the highland tracts and the north country the snow-covering is more constant than in the south country, the mo of which is sometimes covered with snow, sometimes bare.

Table 30 shows the distribution of the species groups in the scale of snow-covering. The signatures are the same as in table 29. The average values are given at the end of the table. It appears from the table with all desirable plainness that the A percentage is highest in the class most bare of snow, i. e. in

I a, (mosathembur); from here its value decreases until it attains its minimum together with the maximum of the E percentage in the class with the deepest snow-covering. The proportion of the average F.-percentages of the two species groups in the class most bare of snow is as 83 to 17, in the class with the deepest snow-covering as 34 to 66.

The variations in the distribution of the individual sub-groups are closely correlated to the variations in the distribution of the main groups. A 3 attains its highest value in the highest class and thence the F.-percentage decreases steadily as we pass downwards through the classes. It shows the following change: 70 → 48 → 35 → 20. The maximum of the A 2 species lies lower in the scale, that of the A 1 species still lower.

The maximum of the latter group is in class II, corresponding to the normal snow-covering of the country. In this class the E species, too, attain their maximum, though not a very pronounced one. The lower E sub-groups, E 3, E 2, and E 1 all have their maxima in class III, corresponding to the fact that the species thrive best where there is a deep and constant snow-covering throughout the winter. Here E 3 is most abundant, E 2 is somewhat less dominant, and E 1 occurs only sparsely.

Thus to the 3 classes of snow-covering there corresponds a vegetation quite definitely stamped by its environment. In class I it consists chiefly of A 3 species, less of A 2 species, in class II of A 2, A 1, and E 4 species, and in class III of E 3, E 2, and E 1 species.

The snow-bare vegetation of Iceland thus consists of species with a pronounced northern distribution, the vegetation with a constant snow-covering of species with a pronounced southern distribution, and the vegetation with a normal snow-covering is composed of species belonging to tracts the climate of which corresponds to that of the country.

Conditions in the individual localities entirely confirm the facts stated above, both in respect of the quantitative distribution in the main groups and the position of the maximum in the individual subgroups. A decrease in the amount of snow will always tend to render the vegetation more arctic, an increase will render it more southern.

This distribution is especially very plainly seen in the highland scale. As everywhere else A 3 attains its maximum in the highest class, which is relatively unfavourable to A 2. The maximum of this group is the second or third highest class, while A 1 does not attain its maximun until yet another degree lower in the scale. In the lowest class there is a rise in the A percentage which would seem to suggest that too large an amount of snow restricts the growth of the southern species but promotes that of the arctic species. The *Salix herbacea, Sibbaldia procumbens* and *Anthelia* societies previously cited must be assumed to be a development resulting from this fact.

The change in the proportion of A and E species as we pass from snowbare to increasingly snow-covered vegetations is the same whether expressed in frequency sum numbers or in the species numbers alone. This is very plainly evident from the species groups spectra in table 8 which have been calculated from Ingimar Óskarsson's species lists from Vestfirðir. The series melar → heather and mo → herbfield and birch copse corresponds to the above-mentioned snow-covering classes I—II—III. The percentage amounts of A, A 3, and E 3+2+1 species in the various groups of vegetation are as follows:

	A percentage	A 3 percentage	E 3+2+1 percentage
Highland melar	82	24	4
Lowland melar	60	22	23
Heather and mo veg. ...	50	13	32
Herbfield and birch copse	23	7	48
Hot springs	»	»	75

Even though the values do not coincide with those given in table 30, the correspondence in the variations of the series of figures is beyond doubt.

A comparison between the species group spectra for the various types of vegetation, partly in the different parts of the country, partly at different heights above sea-level, will be of interest.

Thus the melar vegetation in the south country has a lower A percentage and A 3 percentage, but on the other hand a higher E 3+2+1 percentage than the corresponding vegetation in the north country and the highland tracts. The numerical values are as follows.

	A percentage	A 3 percentage	E 3+2+1 percentage
Melar in S. Icl.	60	36	11
— - N. Icl.	75	52	2
— highland	81	55	»

The corresponding figures for the mo respectively in South Iceland, South-West Iceland, and North Iceland at c. 100 m above sea-level are as follows.

	A percentage	A 3 percentage	E 3+2+1 percentage
South Iceland	33	18	34
S. W. Iceland.	48	25	19
North Iceland	64	39	11

At various heights above the sea the figures in the south country are as follows.

	A percentage	A 3 percentage	E 3+2+1 percentage
At 100 m	33	18	34
- 200 m	50	29	25
- 3—400 m	58	33	25
- 500 m (highl.).	71	41	3

The figures for the geiri vegetation in the south country are as follows.

	A percentage	A 3 percentage	E 3+2+1 percentage
At 200 m	20	12	52
- 3—400 m	36	22	43
- 500 m	44	24	35

For the mosathembur vegetation.

	A percentage	A 3 percentage	E 3+2+1 percentage
At 100 m (the Elyna mo).	52	30	18
- 200 m (the mosathembur veget.)	74	55	5
- 300 m - — —	90	83	3
- 400 m - — —	100	100	»

The figures all point in the same direction; where the temperature conditions are most favourable, the southern species are most abundant, where the cold is predominant, the northern species abound. This relation remains

the same if the species numbers alone are employed instead of the frequency numbers.

The occurrence and quantitative distribution of the species groups in the Icelandic types of vegetation is determined throughout by the temperature conditions prevalent in the locality. The prolonged low temperature prevalent in the highlands and the north country but especially in localities where the snow is blown away in the winter, promotes the growth of northern but restricts the growth of southern species, while a prolonged high temperature, as it occurs in the lowlands and the south but especially wherever the ground is covered with a deep and constant layer of snow, restricts the growth of northern but promotes the growth of southern species. This is abundantly confirmed by the vegetation around the hot springs.

We are thus fully justified in regarding the species groups as indicators of environment, and the species group spectra will then prove an important guide in a more precise analysis of environment. Under the treatment of the distribution of the species groups in the Icelandic scale of moisture, the spectra furnished important holds for an examination of the physical conditions. The legitimacy of the above-stated considerations is further confirmed by the distribution of the species groups in the scale of snow-covering, in the types of vegetation of the different parts of the country and the altitudinal zones, and by the vegetation around the hot springs.

In two areas, partly in the geiri and partly in the flói, on soil covered respectively with snow and with water, the E species are unusually abundant. In both places the winter temperature must be supposed to be almost the same, at or below zero. When the snow has melted in the geiri, the heat that is left will directly benefit the plants. In the flói, on the other hand, a great deal of the heat is latent in the water which still covers the vegetation, consequently the result will be a relatively low summer temperature. The flói is thus warm in the winter but cold in the summer, while the geiri is warm both in the winter and the summer. The result will be that in both places the species group spectrum is characterised by a high E percentage; on the water-covered soil it is 72, on the snow-covered soil 66. The difference in the summer

temperature appears especially in the E group spectrum in that the lower E sub-groups occur abundantly on snow-covered soil, but are entirely absent from water-covered soil. The E 2 and E 1 species are such as require a high temperature to be able to thrive, and this requirement is only satisfied in geiri and forest.

The A group spectrum shows a peculiar difference between the two types of vegetation. The A percentage is 34 in the geiri, 28 in the flói. In the flói 20 p. c. of these species are A 1 species, and only 8 p. c. are A 3 and A 2 species, while in the geiri the A 1 percentage is only 4, and the sum total of the A 3 and A 2 percentages is no less than 30.

The high A 3 percentage in the snow-covered vegetation and the low A 3 percentage in the water-covered vegetation must be assumed to be a consequence of difference of stability in the covering medium. In the flói the water is always present, hence the vegetation is never exposed to severe cold. Thus a condition necessary for the growth of A 3 species is not present.

Compared with the water in the flói, the snow in the geiri is less stable. A hard frost may set in before the first snowfall, and frost in the night may affect the vegetation after the snow has melted. This provides a possibility for the growth of the A 3 species, hence compared with water-covered soil the A 3 percentage is high, but compared with snow-bare soil or a vegetation with a normal snow-covering, it is comparatively low. The A 3 percentage is higher in geiri than in forest, respectively 23 and 14, which further confirms the above considerations.

Thus the difference between the species group spectra for water-covered and snow-covered vegetation is as follows. The species in the species group spectrum of the water-covered vegetation are largely concentrated in the central part of the spectrum with a marked dominance of E species, corresponding to a favourable and fairly stable winter temperature, and only a slight difference between the winter and summer temperatures. The species in the species group spectrum of snow-covered soil, on the other hand, though also showing a preponderance of E species, are distributed over the entire scale in consequence of a relatively high winter and summer temperature, and greater instability in the winter.

As previously mentioned, the species group spectrum for the

Subularia flag, the water-covered vegetation rich in Th, corresponds closely to that of the flói: concentration of the species in the central part, and preponderance of the E species.

The treatment of the distribution of the species groups and the life-forms in the scale of moisture showed that moderately moist soil (jaðar) caused a relative maximum of E species, hemicryptophytes and therophytes. This was the case with the vegetation on a gently sloping surface with even transitions from one type of vegetation to another. However, on moderately moist soil there occurs a series of types which, physiognomically, are rather different, both mutually and in relation to the jaðar, but which, on close inspection, prove to be possessed of the pecularities of the jaðar vegetation, though in varying degree, viz. a relatively high H percentage and Th percentage. Of these types the valllendi and flag vegetations have so far been examined. The first of these types develops on the flat cones deposited by the rivulets of melting snow on flat ledges. The valllendi soil is thus saturated with water until the last snow has melted, i. e. until the geiri is bare of snow. In the flag, conditions are otherwise. If it receives any water at all while the snow is melting, it is at most as long as there is snow on the mo. The bare soil of the flag is thus exposed to the effects of the frost (night frost) much longer than the valllendi, which is furnished with fresh water daily. Hence it is hardly accidental that the E species are more dominant in valllendi than in flag. The E percentages for valllendi, jaðar, and flag are respectively 75, 53, and 42.

The Distribution of the Life-Forms in the Scale of Snow-Covering.

Since differences in respect of snow-covering only appear in areas not affected by ground-water, where, as previously mentioned, Ch, H, and Th are the dominant life-forms, it is principally the relation of the snow to these which is of interest. Table 30 shows the biological spectra of the various classes of snow-covering in the localities examined by me. At the bottom of the table are given the mean values for all the investigations.

It appears from the table with all desirable plainness that Ch are more abundant on snow-bare soil than on soil with a normal snow-covering, and more abundant there than where the soil has a constant snow-covering. For H the case is re-

TABLE 30. **The Distribution of Species Groups and Life Forms in the Scale of Snow Covering.**
1. Björk. 2. Lýngdalur. 3. Thrasaborgir. 4. Lækjamót.
5. Norðtunga. 6. Arnarvatnsheiði. 7. Average.

	Points sum	Number of species	Density of species	A	E	A3	A2	A1	E4	E3	E2	E1	Ph.	Ch	H	G	HH	Th
1a ...	4536	29	11.4	**52**	48	**30**	**11**	**11**	30	11	5	2	»	28	56	16	»	»
b ...	4096	30	13.6	33	**67**	18	9	6	**33**	**13**	**21**	0.3	»	**39**	47	14	»	0.2
Ia 2a ...	1228	9	2.4	**75**	25	**55**	**18**	2	21	1	4	»	»	10	41	48	»	»
Ib b ...	3852	18	5.5	**60**	40	36	**19**	5	30	10	1	0.2	»	43	39	18		
(Ia-II) c ...	860	27	8.6	57	43	35	14	7	27	10	6	»	»	23	51	26	»	0.5
II d ...	6644	34	13.3	**50**	**50**	29	10	**11**	25	14	10	1	»	26	56	17	»	0.3
III e ...	7418	25	10.6	20	**80**	12	3	5	28	**26**	**24**	**2**	»	35	55	10	»	»
Ia 3a ...	1340	9	2.2	**91**	9	**85**	7	»	6	»	3	»	»	57	8	35	»	»
II b ...	1924	22	9.6	**58**	**42**	33	**16**	**9**	17	17	8	0.2	»	25	56	18	»	0.2
III c ...	2064	31	10.3	36	**65**	22	11	3	**21**	**27**	**16**	0.2	»	34	49	17	»	0.2
Ib 4a ...	2058	27	6.9	**75**	26	**52**	16	7	24	1	1	0.2	»	45	47	5	»	3
II b ...	3480	39	17.4	**64**	**36**	39	18	7	25	7	4	0.1	»	35	49	14	»	2
II 5a ...	1392	31	13.9	**48**	**52**	25	15	8	33	9	10	»	»	29	55	16	»	0.3
III b ...	4316	43	10.8	30	**70**	14	10	5	27	28	11	4	»	17	70	14	»	»
(III) c ...	1276	23	6.4	25	**75**	13	10	3	17	46	11	1	»	8	75	17	»	»
Ib 6a ...	4748	27	7.9	**81**	19	**55**	20	6	19	»	»	»	»	52	36	10	»	2
II b ...	5664	32	11.3	**70**	30	43	**24**	3	30	1	»	»	»	48	37	15	»	1
II c ...	7184	35	14.4	**71**	29	39	**25**	**7**	24	4	»	»	»	38	47	15	»	0.3
III d ...	3892	32	13.0	**44**	**56**	24	13	**7**	21	27	6	2	»	31	53	16	»	0.2
III e ...	2000	21	10.0	48	**52**	34	13	1	24	23	5	»	»	35	43	22	»	»
7. Ia ...	2568	9	2.3	**83**	17	**70**	13	1	14	1	4	»	»	27	40	**33**	»	»
Ib ...	10.658	24	6.8	**72**	28	**48**	**18**	6	24	4	0.5	0.1	»	**47**	41	11	»	2
II ...	26.288	**32**	**13.3**	**60**	**40**	35	**18**	**9**	**26**	9	5	0.2	»	**34**	**50**	16	»	1
III ...	20.966	29	10.2	34	**66**	20	10	4	23	**30**	**12**	**1.5**	»	27	**58**	16	»	0.1

versed, this group occurs in greatest quantity on soil with a constant snow-covering, while the Th group behaves like Ch.

If instead of the values for frequency we use the species number alone, the result will be the same. The Th percentage for snowbare soil, soil with a normal snow-covering, and soil with a constant snow-covering at Vestfirðir, calculated from Ingimar Óskarsson's species lists, is respectively 37, 24, and 20.

Hence the following rule applies to the distribution of the life-forms in the Icelandic scale of snow-covering. On the most

snow-bare soil Ch thrive best, the deeper the snow-covering the more does the Ch percentage decrease, while, on the other hand, the H percentage increases, and where the snow-covering is deepest, H play the most prominent part. This distribution must be regarded as a consequence of the geographical distribution of the life forms. Ch, the arctic life-form, thrive best where the cold has the strongest effect, while the more temperate life-form, H, shows a preference for conditions in which there is the greatest protection from the cold.

From this rule of the distribution of the life-forms in the Icelandic scale of snow-covering there is an interesting, though merely apparent, deviation, as will appear from a close investigation of conditions in the individual localities. In the highlands the rule applies throughout, the slighter the snow-covering, the higher the Ch percentage (though in the very lowest class there occurs an increase), and in the lowlands too it holds good if we consider the relation between melar and mo, i. e. between snow-bare and snow-covered soil. In other respects conditions in the lowlands seem to go against the rule, Ch playing the most prominent part where the snow-covering is deepest and of the longest duration, whereas this group decreases when the depth of the snow-covering decreases. The Ch percentage in the Elyna mo, the comparatively snow-bare formation at Bjørk, is 28, whereas, in the Arctostaphylos mo, the relatively snow-covered formation, it is 39. In the mo at Lýngdalur the Ch percentage is 26, in the geiri 35, and in mosathembur only 10. At Thrasaborg the values for mo and geiri are 25 and 34 respectively.

This difference in the distribution of Ch in the highland and the lowland scale of snow-covering is due to the fact that the Ch vegetation in the lowlands consists especially of E species, whereas, in the highland tracts, it consists of A species. This disagreement thus handsomely confirms the distribution of the species groups in the scale of snow-covering.

Raunkiær examined the variations in the biological spectra in sections from southern towards northern regions (1908, 1911) and showed that some life-forms, Ph, K, and Th, decrease in quantity, while others, Ch, increase and others again, H, undergo no appre-

ciable change, are indifferent. Passing upwards from the level of the sea to the snow-line in a mountain district, we find the same changes.

In Iceland the same holds good for the variation according to altitude: The H percentage remains unchanged throughout the altitudinal zones, the arctic life-form Ch increases rapidly, while the southern life-forms, Pt, Ph, G, HH, and Th, decrease in the same proportion.

These changes in the life-form spectra are connected with, or caused by, a decrease in the warm temperature of the summer and an increase in the cold temperature of the winter. The summer temperature grows lower and the summer of shorter duration, while, on the other hand, the winter grows longer and more severe the further northward we go.

If we calculate the biological spectra for the Icelandic types of vegetation and compare the spectra for the types on snow-bare soil, on soil with a normal snow-covering, and on soil with a constant snow-covering, we get the same variations as above on passing from arctic towards temperate regions or from the snow-line towards the level of the sea.

The result will be the same whether we base our calculations on the number of species or on the number of individuals, i. e. on the frequency sum.

There is no reason to believe but that, in this case too, it is the temperature conditions which determine the occurrence and development of the life-forms. The temperature conditions favourable to the artic species are due to the fact that the snow is blown away so that the cold can act with its full force on the vegetation with the result that southern types cannot survive, while arctic types thrive. Where the snow-covering is deep and constant, the case is reversed; here the environment will be unfavourable to arctic but favourable to temperate types because the snow-covering will prevent the extreme variations in temperature from reaching the vegetation.

Hence, under conditions where the external factors are not easily observable, the individual life-forms may with full justice be employed, as above, as indicators of environment. Thus, in Iceland, many Ch will indicate severe cold, many Ph, K, and Th relatively favourable temperature conditions.

From a scientific point of view, as a means of checking life-

forms, it will be of interest to have another system of indicators of environment. In the present treatise the geographical distribution of the individual species has been employed as an indicator of environment. A species with a pronounced southern distribution will more certainly indicate a high temperature than a more northern species. The more southern species there occur in an area, and the more prominent the role they play, the more probable will it be that the temperature conditions are favourable. Reversely, it must be supposed that a preponderance of arctic species indicates severe cold. *The proportion of southern and arctic species in an area will therefore indicate the temperature conditions of that area.*

In a previous chapter the species groups were dealt with in more detail. At the outset it might be anticipated that the species groups would be more sensitive indicators than the life-forms, and it might be claimed that the two systems of indicators should lead to the same result. An inspection of the tables will show to how great an extent this is the case. A change of environment causing an increase of the Ch percentage will likewise cause an increase of the A percentage, and numerically this increase will be greater than the Ch increase.

Table 31 shows the life-form and species group spectra for a series of areas in which the conditions of environment are most clearly illustrated. The localities are arranged in groups of 3 each. The top group 1, comprises the land spectra for Denmark, Iceland, and North Greenland, group 2 the Icelandic zone spectra for the lowlands and the upper and lower zones of the highlands respectively, group 3 various zone spectra from Vestfirðir, for the 0—100 m zone, the 2—300 m zone, and the 3—400 m zone respectively, group 4 shows vegetation spectra for snow-bare, normally, and constantly snow-covered vegetation in the same locality, and group 5, finally, gives the mean values for the formation spectra of the various classes of snow-covering. Within each group the coldest area, a, is given first, the warmest, c, last.

A closer inspection of the table will show that, compared with the b spectra, all the a spectra have a high Ch percentage, A 3 percentage, and especially a high A percentage, while the c spectra, on the other hand, have a high (Ph + K + Th) percentage and (E 3 + E 2 + E 1) percentage. The amount of H and (A 2 + A 1 + E 4) species is relatively unaffected by changes in temperature in any

TABLE 31. **Agreement in Variation of Biological Spectra aud Species Group Spectra** (cf. Text).

		Ch %	H %	Ph K Th %	A %	A 3 %	A 2, A 1, E 4 %	E 3+2+1 %
1. N. Greenland	a	**35**	**50**	15	»			
Iceland	b	15	**52**	33	»			
Denmark	c	3	**50**	**47**				
2. Iceland. 8—1200 m. above sea	a	**34**	**53**	13	80	**58**	**38**	5
— 3—800 m.	b	21	**53**	26	52	20	**49**	31
— 0—300 m.	c	15	**52**	**33**	40	15	**41**	**44**
3. Vestfirðir, 4—500 m above sea	a	**43**	**50**	7	93	**50**	**50**	»
— 2—300 m.	b	31	**51**	18	68	27	**56**	17
— 0—100 m.	c	17	**52**	**31**	41	15	**47**	**38**
4. Snow-bare vegetation Vestfirðir	a	**37**	**52**	11	71	**32**	**54**	14
Normally snow-covered vegetation	b	24	**55**	21	50	13	**55**	32
Constantly snow-covered vegetation	c	20	**51**	**29**	28	7	**45**	**48**
5. Snow-covering class I	a	**47**	41	12	72	**48**	**47**	5
— - II	b	34	**50**	16	60	35	**51**	14
— - III	c	27	**58**	15	34	20	**36**	**44**

direction; in all the spectra these two groups constitute about half the material.

The effect of a change in temperature is thus the same in both systems of indicators, but it is most marked in the species group system.

Hence, when we have elsewhere in this treatise employed the species group and life form spectra when considering the external factors prevalent in the formations, this is quite justifiable; a spectrum, particularly a species group spectrum, will thus be an important guide in the determination of the external factors which are of importance for the vegetation.

Variations in the density and number of species in the scale of external factors bring to light interesting relations. In the 4 classes of snow-covering I a, I b, II, and III, the mean density of species is respectively 2.3, 6.8, 13.3, and 10.2, and the mean number of species is 9, 24, 32, and 29; in the 7 classes of moisture the mean density of

species from class I to class VII is given by the following values: 8.3, 12.7, 14.3, 13.2, 11.1, 7.9, and 1.8 and the mean number of species in the corresponding classes by 25, 32, 36, 39, 33, 19, and 5. It applies both to the number and density of species that they attain a maximum in both scales of external factors, whence they decrease more or less in both directions. The position of this maximum corresponds to the conditions of environment normally prevalent in the country, and practically coincides for both series of figures. The maximum for the scale of snow-covering lies in class II, corresponding to the mo, for the scale of moisture it lies in classes III—IV, corresponding to moist mo and jaðar. These types of vegetation must be regarded as the climax vegetation of the country.

The rule thus seems to hold good that those parts of the country where the environment is typical of the country and which, therefore, bear the *climax vegetation of the country, have the vegetation which is richest and densest in species. No matter in what direction the external factors are changed, whether in the direction of greater drought or greater moisture, or in the direction of a deeper or a slighter snow-covering, the result will always be a diminution both of the number and of the density of species, and the greater the change of environment, the greater the diminution.*

Our investigation of the distribution of the species, species groups, and life-forms in the formations, arranged according to increasing prevalence of one and the same external factor, has herewith been brought to a close as far as the Icelandic scales of moisture and snow-covering are concerned. Besides extending the investigations to an increased number of external factors, it will likewise be appropriate to divide the flora into groups according to the distribution of the species from Atlantic to more continental regions. It would also seem of interest to divide the flora into groups according to the geographical distribution of the *genera*, as well as according to the *quantitative distribution* of the species within their areas. Judging by the investigations given above, such an extension of view-points would lead to a more thorough understanding of the distribution of plants in Iceland, the knowledge of which is essential partly for the question of the genesis

of the Icelandic species, partly for the question of the cultivation of the various Icelandic types of vegetation.

Other questions of decisive importance in studies on the distribution of the species in the scales of external factors are partly the question of equidistance in division, and partly the question of the determination of the number of external factors bearing on plant distribution.

As far as the first question is concerned, in formations with low density of species, the line between two formations is most naturally drawn at the physiognomic boundary line between the two formations, and the areas selected for examination should as far as possible be laid in the middle of the formation. It is possible that the distance between the various localities examined will not in this way become an exact expression of physical equidistance between the localities, or the formations, but merely of ecological equidistance: but since the investigation is primarily ecological, it will suffice if the requirement of ecological equidistance is satisfied, even though physical equidistance would have been desirable.

Where we are concerned with the investigation of formations with many species, the requirement of ecological equidistance between the localities examined will be considerably more difficult to satisfy. The present treatise deals principally with formations of this kind, and the examination of them was made in the following way. On a gently sloping surface the investigator passed so far up and down from one locality that the vegetation had changed appreciably; the second locality was then examined here, whereupon the third locality was chosen and examined in the same way.

It is possible that the distances between the localities examined are unequal both physically and ecologically; so much is certain, however, that the sequence of the localities examined expresses a constantly increasing change of environment. If this is the case, however, we have in the proportion of the species points of species occurring principally above, and species occurring principally below, the formation in question an aid in determining the question of ecological equidistance between the formations.

Another question of equal importance is the question of the determination of the number of plant-distributing factors. This question, however, is only topical in a plant covering rich in species and of uniform physiognomy. If such a plant covering is examined

by means of Raunkiær's circling method, the flora lists of the individual random samples will furnish a point of departure for the consideration of this subject.

This question, as well as the others referred to above, I have, however, been obliged to leave for future consideration, partly for lack of time, partly for want of suitable material. A few more questions, thus some investigations on the acidity of some types of Icelandic vegetation, and some reflections on the relation between plant geography and farming, will be dealt with briefly below.

Determinations of the acidity of the soil were made simultaneously with the investigation of the vegetation. The mode of procedure in taking samples of the soil and determining the degree of acidity was that described by Carsten Olsen (1921). For practical reasons the investigation was only made at Bjørk, on Lýngdalsheiði, and on Arnarvatnsheiði.

For the various types of vegetation in the above-mentioned localities the acidity expressed in p_H was as follows:

At Bjørk		
Elyna mo	6.5, 6.5	average 6.5
Arctostaphylos mo	6.5, 6.5, 6.4	— 6.5
Calluna-Empetrum mo	6.4, 6.3	— 6.4
Jaðar	6.0, 6.0	— 6.0
Salix mýri	6.0, 5.7, 5.7	— 5.8
Betula nana mýri	5.7, 5.6, 5.2, 5.2	— 5.4
Koenigia flag	6.6, 6.3	— 6.5
On Lýngdalsheiði		
Mosathembur	6.5, 6.4, 6.3, 6.3	— 6.4
Melar	6.3, 6.3, 6.2, 6.2	— 6.3
Mo	6.4, 6.4, 6.4, 6.4, 6.3	— 6.3
»	6.2, 6.2, 6.2. 6.2	
Valllendi	6.3, 6.2, 6.1, 6.1, 5.7	— 6.1
Jaðar	6.0	— 6.0
Salix mýri	5.3	— 5.3
Betula nana mýri	5.3, 5.1, 5.1, 5.0, 5.0, 4.8, 4.8	— 5.0
Geiri	6.1, 6.1, 6.0	— 6.1
On Arnarvatnsheiði		
Melar	6.9, 6.8, 6.7, 6.6, 6.6	— 6.7
The level mo	6.8, 6.8, 6,4, 6.3, 6.2	— 6.5

The knolly mo	6.8, 6.8, 6.4, 6.2	average 6.5
Jaðar	6.2, 6.2, 6.1, 6.1	— 6.2
Mýri	6.3, 6.1, 6.0, 5.9, 5.9, 5.6	— 5.9
Geiri (Geranium belt) ...	6.5, 6.4	— 6.3
— (bottom veget.)	6.3, 6.1	—

Thus the Icelandic soils all seem to be slightly acid; no degrees of acidity above the neutral point were measured, nor did any very strongly acid soils occur. The highest value measured in p_H was 6.9, the lowest 4.8; according to C. Olsen, the corresponding values for Denmark are respectively 8.0 and 3.4. There is this connection between the moisture of the soil and its degree of acidity that increasing moisture produces increasing acidity, i. e. decrease in p_H value. In melar p_H is about 6.7, in the mo 6.3—6.5, in jaðar 6.0—6.2, and in mýri 5.2, 5.5, and 5.9. An increase in the depth of snow-covering shows the same relations: in melar p^H is 6.7, in mo 6.3—6.5, and in geiri 6.1—6.3.

—

The investigations described in the present treatise are not only of phytogeographical and botanical interest, but would also seem to have some bearing on practical matters, partly in agricultural research, and partly more directly in farming. Since, however, these matters have not been subjected to special investigation and are outside the scope of the present treatise, I shall merely make brief mention of a couple of questions connected herewith.

Under the treatment of the vegetation the appearance of the surface in the individual types was described. A comparison between this and the species group spectra reveals the following facts. When the E percentage is high, i. e. when the vegetation consists of southern species, the surface is always level, without any formation of knolls, whether the high E percentage is caused by a deep layer of snow or by the soil being covered with water. If, reversely, the vegetation consists mainly of arctic species, solifluction is always seen. If the vegetation consists of an equal mixture of A and E species knolls will always be met with.

This difference between the types of surface connected with the different types of vegetation must be assumed to be a result of the same external factor that determines the differences in vegetation, in this case the cold. In geiri and flói (snow-patch and

swamp) the soil is protected from the frost and therefore even; in mo, jaðar, and (mýri) the frozen surface will crack in the spring, as in Denmark, and form greater or smaller polygons which will furnish a foundation for the formation of knolls. How this latter takes place is still uncertain. It seems natural to suppose that it is due to the action of frost which may also be observed in Denmark when clayey or boggy soil freezes. On such soil, which has been exposed to a long period of frost, the surface will be observed to have been raised in various ways, and the frozen crust will be seen to consist of alternate layers of ice and frozen earth. When the water freezes the whole mass of soil expands upwards, either in the shape of a large cake or as a radiating system of branches of ice and earth. The greater the moisture and the longer the action of the frost, the more marked is this phenomenon. If the Icelandic formation of knolls is a result of the same forces, it may be anticipated to be most pronunced on moderately moist soil and in regions where frosts are frequent. And, as a matter of fact, the formation of knolls attains its handsomest development in jaðar in the highlands where precisely these two conditions are present.

According to this view the knolls (in mo and jaðar) should be a kind of "frost-baked earth-balls", for which the polygonal soil forms the point of departure. F r o s t is the agent and water the expanding factor which, on freezing to ice, changes the internal structure of the knoll from a relatively compact to a more porous state. In accordance herewith it will, in fact, be observed that the interior of the knolls is peculiarly loose, almost like flour.

If there is a continued formation of knolls it will, in regions much exposed to wind, become a starting point for solifluction. The surface of the knolls will break on the side exposed to the wind, and will at last be entirely eaten up by erosion. In areas where the action of the frost is relatively strong, as in melar, knolls will form the starting-point for solifluction.

The above considerations are merely of a sketchy nature. On the basis of general observations and the knowledge of external factors drawn from phytogeographical investigations I have attempted to correlate a series of peculiar soil phenomena. By a more methodical investigation of these in connection with a simultaneous phytogeographical investigation a better understanding of these factors, so important to Icelandic farming, might no doubt be gained

—

By the investigations described in the present treatise it has been shown how, within 3 areas in normal Icelandic physical conditions, favourable conditions for southern species are created, and thus a vegetation, the luxuriance of which permits of grazing or haymaking. These areas are either soils protected by water or by snow, or moderately moist soils which combine the favourable temperature conditions in winter of moist soils with the favourable temperature conditions in summer of dry soils.

The value of these areas for farming is caused by the fact that southern species and life-forms are larger and more vigorous, produce more matter than northern ones. Hence one of the chief aims in cultivating infertile areas should be to make such changes in the prevalent external factors that from being favourable to Ch they become favourable to H or G, according as the soil to be cultivated is comparatively dry or comparatively moist. The means employed for this purpose have been, partly a change in the conditions of moisture, partly in the conditions of nutrition. The results have, however, been very varied. The experiments have been most successful in the case of mýri, which it has been attempted to cultivate partly by irrigation, partly by draining. It is obvious that irrigation must result in favourable conditions for southern plants, since it increases the medium of protection against the winter cold. If the water is drained off in the summer, this will merely be a further advantage, since a lot of heat which would otherwise be latent in the water now becomes available for the plants. As a matter of fact, the transformation of mýri into irrigated mýri plays a prominent part in Icelandic farming.

The second way in which mýri may be transformed is by draining. In that way moist soil is transformed into moderately moist soil, mýri to tún. This change in moisture in connection with the addition of manure will have the effect of gradually replacing the sedge vegetation of the mýri, rich in G, by the grass vegetation of the tún, rich in H — a vegetation identical with the jaðar vegetation. Thus draining also produces a more southern vegetation, and the causes have previously been mentioned.

In the cultivation of the mo it has especially been attempted to transform it into tún. By treating the soil and adding manure to it, it has been attempted to make the jaðar plants grow here, and with some success. Hitherto, however, the object has been to transform a less southern to a more southern type of vegetation

but without a simultaneous change of the environment in the same direction. As a matter of fact the result is that "the tún burns" after cold winters and in hot summers, which is due to the fact that in the winter the plants miss the protection afforded by the jaðar soil, and in the summer its moisture.

Even if a transformation of mo to tún is not as profitable as the transformation of mýri to tún, it must, however, on the whole be an advantage to farming. It is, however, questionable whether this is the right way of cultivating the mo. The investigations described in the present treatise have shown that water is the means of protection for southern plants on moist soil, while snow protects southern plants on the drier soils. Hence if a cultivation of the mo equally effective to that of the mýri is desired, it should tend to utilise our knowledge of the importance of the snow-covering rather than aiming at the continued transformation into tún.

The importance of the snow-covering for the southern plants, and hence for the plants valuable to farmers, has long since been very thoroughly brought home to all parties concerned.

When the first Icelanders came to the island, c. 874 A. D., the country was covered with woods "milli fjalls ok fjäru". This however, is probably an exaggerated statement, says Thoroddsen, "but it is quite certain that the lowlands and valleys must have been more abundantly clothed with copse wood then than now, even if it must be assumed that large stretches of sandar, mýrar, and lava fields were also then devoid of woods." Thoroddsen supposes, however, that when Iceland was first settled, the woods extended to an altitude of 600 m above sea-level, and that, at the beginning of the 10th century, they covered an area of 4—5000 sq. km. In 1911 the total wooded area had been reduced to 454 sq. km.

According to Helgi Jónsson (1900 p. 76), this great reduction has been caused by "reckless exploitation". But by destroying the trees, the constant snow-covering which was dependent on the presence of wood was also destroyed and, simultaneously, the luxuriant forest undergrowth which was again dependent on the snow-covering, and which formed, entirely or partially, the food of the farm animals. The great decline in old Icelandic culture, which numerically resulted in the population being reduced to half its former number, must no doubt be directly referred to the destruction of the woods. The correlation between these two factors has been outlined above.

APPENDIX.

Temperature Conditions in the Upper Soil Strata.

Apart from volcanic regions, where the upper soil strata receive heat from the interior of the earth, temperature conditions at the surface are practically determined by insolation. According to the extent of the cloud-covering, a greater or less amount of heat will reach the surface of the earth where part of it will be used for heating the air, another part for evaporation of the water in the soil, and a third part, finally, will heat the upper soil strata.

Investigations on the temperature conditions in the upper strata of the soil have been made at a series of stations in the most different climates. An accessible presentation of the questions relating to this subject will be found in Ramann, Bodenkunde 1911 and Hann, Lehrbuch der Meteorologie 1926, to which the reader is referred. A series of these investigations are, however, of such great phytogeographical interest in their bearing on the investigations described in this treatise that a brief abstract of the main results will be given in the following.

The investigations referred to originate partly, and especially, from Finland, and partly from Russia, and were made by Th. Homén (1894, 1896, 1897) J. Keränen (1920), and H. Wild (1897). The investigations comprise the daily and annual variations in temperature in snow and sandy soil, the temperature of the surface with and without snow-covering, and the daily variations in temperature in different kinds of soil, different in regard to structure, water-content, and plant-covering.

As an example of the daily variation in temperature in snow and sandy soil may be mentioned J. Keränen's investigations from Sodankylä of which an abstract is given in table 32 1–2. The temperature was measured every second hour throughout the 24 hours in the surface of the soil or the snow at different depths, in the case of the snow at depths of 4, 14, 24, and 44 cm. and in the case of the sandy soil at 10, 25, 40, 80, and 120 cm. The temperature of the air is given for each investigation.

The temperature of the surface of the snow or the sandy soil is determined by the proportion of insolation and radiation. Radiation is greatest in the night, hence the temperature decreases so that the lowest degrees of temperature occur just before sunrise; in

TABLE 32.

The Daily Variation in Temperature in Air, Snow, and Soil at Sodankylä (Finland, 67° 22′ N., 26° 39′ E.).

1. Temperature measurements for snow, made 19—20 March 1917. After Keränen 1920, p. 92.
2. Temperature measurements for soil, made 25—29 June 1917, l. c. 196—197.

		0	2	4	6	8	10	12	14	16	18	20	22	24	M	Diff.
Air . . . . . . C°		÷ 35.7	÷ 37.9	÷ 39.4	÷ *40.4*	÷ 34.5	÷ 20.4	÷ 15.3	÷ **12.7**	÷ 13.4	÷ 16.9	÷ 26.3	÷ 31.9	÷ 34.4	÷ 27.6	27.7
1. Snow	0 cm	÷ 37.7	÷ 38.9	÷ 40.0	÷ *40.1*	÷ 36.5	÷ 24.0	÷ 15.9	÷ **14.4**	÷ 20.8	÷ 28.1	÷ 32.9	÷ 34.7	÷ 36.8	÷ 30.2	25.7
	÷ 4 -	÷ 30.0	÷ 31.7	÷ 33.0	÷ *33.9*	÷ 32.9	÷ 25.7	÷ 14.7	÷ **12.0**	÷ 15.9	÷ 21.0	÷ 25.1	÷ 27.6	÷ 29.6	÷ 25.1	21.9
	÷ 14 -	÷ 19.0	÷ 20.1	÷ 21.0	÷ 22.0	÷ 22.5	÷ 22.1	÷ 20.1	÷ 17.8	÷ **16.6**	÷ **16.6**	÷ 17.5	÷ 18.1	÷ 19.0	÷ 19.4	5.9
	÷ 24 -	÷ **13.7**	÷ 13.9	÷ 14.2	÷ 14.7	÷ 14.9	÷ *15.1*	÷ *15.1*	÷ 14.9	÷ 14.7	÷ 14.5	÷ 14.2	÷ 14.0	÷ 14.0	÷ 14.5	1.4
	÷ 44 -	÷ 7.3	÷ 7.4	÷ 7.3	÷ 7.5	÷ 7.5	÷ 7.6	÷ 7.5	÷ 7.7	÷ 7.7	÷ 7.7	÷ 7.7	÷ 7.7	÷ 7.7	÷ 7.6	0.4
Air . . . . . . C°		13.0	*11.1*	12.0	14.6	16.6	18.5	19.1	**19.7**	19.4	18.3	17.0	15.1	13.2	16.0	8.6
2. Soil	0 cm	10.4	*9.5*	9.8	16.0	20.9	29.4	**31.5**	30.9	27.5	21.7	16.5	12.9	11.0	19.9	22.0
	÷ 10 -	16.0	14.7	13.7	*12.8*	13.0	14.6	17.1	19.0	20.0	**20.1**	19.3	17.9	16.6	16.5	7.3
	÷ 25 -	14.6	14.3	13.7	13.0	12.3	*11.9*	12.3	13.2	13.9	14.8	15.2	**15.3**	15.1	13.7	3.4
	÷ 40 -	12.9	13.0	12.9	12.6	12.2	11.9	*11.8*	12.0	12.3	12.6	12.9	13.2	**13.4**	12.6	1.6
	÷ 80 -	9.1	9.2	9.2	9.1	8.7	*8.5*	*8.5*	8.6	8.8	9.0	9.2	9.3	**9.5**	8.9	1.0
	÷ 120 -	4.6	4.6	4.6	4.6	*4.5*	*4.5*	4.6	4.6	4.7	4.7	4.7	4.8	**4.9**	4.6	0.4

the day, on the other hand, insolation is greatest, and the temperature increases until, simultaneously with or some time after the maximum of insolation, it attains its maximum value. In the course of the afternoon, evening, and night, insolation decreases and with it the temperature until it again attains its minimum at sunrise the next morning. Deviations from these typical relations occur with irregular conditions of cloud-covering.

From the heated surface of the earth a current of heat now passes partly upward to the air, partly downward to the deeper-lying strata, and this current of heat is not arrested until the temperature at the surface of the earth has again dropped below that of the surroundings, at which juncture the current of heat begins to change its direction. The surface of the earth now receives heat from the lower strata and, though to a less extent, from the lower layers of the air. The result will then be that shown in table 32 1—2. The daily variation in temperature is greatest at the surface, thence it decreases upwards as well as downwards until it becomes practically zero, which value is attained at different depths, varying according to the heat-conducting power of the different kinds of soil.

Thus, it appears from table 32 that the daily variation in temperature penetrates far deeper into sandy soil than into snow. In snow the daily variation will as a rule be imperceptible at a depth of 10—20 cm., whereas in sandy soil it is not imperceptible until at a depth of c. 30—50 cm. This agrees well with the much smaller heat-conducting power of the snow. Other kinds of soil show still greater deviations, thus table 35 shows that granite rock has a considerably greater heat-conducting power, boggy soil on the other hand, considerably less heat-conducting power than loose sandy soil.

Another fact will appear from table 32, viz. the displacement of the moment of incidence of the maximum and the minimum at the various depths. While the temperature at the surface of the snow attains its maximum at 14 o'cl., this will not occur until 16—18 o'clock at 14 cm.s depth, and not until 24 o'clock at 24 cm.s depth. The temperature minimum varies in the same way.

The annual variation in temperature is as the daily variation. In the summer an unbroken current of heat will pass from the surface of the soil into the deeper-lying strata, in the winter the current will pass in the opposite direction. The annual amplitude will likewise decrease strongly with the distance from the surface, just as a displacement of the moment of incidence of the

maximum and minimum will take place at the different depths. Thus the temperature minimum in the lower strata will only occur simultaneously with the temperature maximum at the surface, and reversely.

The daily and annual mean temperature of the surface of the earth is higher than that of the air, just as the daily and annual amplitude is higher for the surface than for the air.

TABLE 33. **The annual Rise of Temperature**

in Soils with or without Vegetation or Snow Covering at Pawlowsk (Russia.) The figures give the mean values of a period of 5 years, 1891—95. After H. Wild 1897 p. 7.

	November	December	January	February	March	April	May	June	July	August	September	October	Years
ıow covering cm	3	16	31	46	49	19	»	»	»	»	»	»	(27)
ouds	8.3	8.5	8.3	7.4	6.5	5.9	5.9	6.1	6.6	6.6	7.0	7.6	7.0
ir temperature C°	÷2.0	÷6.4	÷10.2	÷10.0	÷4.5	2.0	9.1	13.4	15.9	13.8	8.7	4.0	2.8
atural external surface .	÷2.5	÷6.8	÷10.3	÷10.3	÷6.1	2.0	12.3	17.4	19.4	15.7	9.2	3.5	3.6
ındy surface 0 0 cm	÷2 6	÷6.6	÷10.4	÷ 9.6	÷3.5	4.3	12.3	16.7	18.9	15.5	9.0	3.6	4 0
÷ 40 »	0 9	÷2.6	÷ 6.1	÷ 6.4	÷2.4	1.8	8.3	13.3	16.7	15.2	9.8	5.4	4.4
÷ 80 »	3.3	0.7	÷ 1 9	÷ 2.7	÷1.2	0.2	4.9	10.1	14.1	13.9	10.3	6.9	4.9
÷160 »	5.7	3.8	2.2	1.2	0.8	**0.8**	2.4	6.2	10.0	11.3	10.3	8.2	5.2
egetation or snow covered surface 0.0 cm.........	÷0.8	÷2.4	÷ 2.4	÷ 1.4	÷0.7	2 6	9.8	14.7	17.0	14 2	9.0	4.2	5.3
÷ 40 »	3.4	1.7	0.9	0.8	0.7	1.4	7.7	11.6	14.6	14.7	11.1	7.3	6.3
÷ 80 »	4.9	3.0	2.0	1.7	1.5	1.7	6.1	9.7	12.6	13.5	11.2	8.3	6.4
÷160 »	6.6	4.7	3.5	3.0	2.6	2.4	4.5	7.5	10.0	11.6	11.0	9.1	6.4

The facts described above apply to bare homogeneous sandy soil, as investigated by H. Wild at Pawlowsk, cf. table 33. If, on the other hand, the surface is clothed with a natural vegetation or covered with snow, a case likewise investigated by H. Wild in the same locality and shown in table 33, the facts will be otherwise. A bare sandy surface has a mean annual temperature of 4.0° with an annual amplitude of 29.2, a natural surface has a mean annual temperature of 3.6° and an annual amplitude of 29.2. The surface under snow and vegetation, on the other hand, has a mean annual

temperature of 5.3° and an annual amplitude of 19.4. Thus, while a natural surface is on the whole similar to a bare sandy surface, the presence of a covering of vegetation or snow will cause a reduction of the annual amplitude of c. 10° and an increase of the mean annual temperature of no less than 1.30.

This applies to the surface of the soil, but the deeper-lying strata too are affected by a covering of snow or vegetation, and in the same direction. There will be a decrease in the annual amplitude and an increase in the mean annual temperature. A comparison between the two sides of table 33 will show the numerical values.

A covering of vegetation will, in the summer, cause a lower average monthly temperature of the surface below it than the natural surface or a bare sandy surface would have done. This difference will, however, only amount to a couple of degrees. In the winter, however, a covering of snow will mean an immense increase of the surface temperature under the snow compared with that above the snow. According to Wild, a snow-covering of 30—45 cm.s' depth will cause a temperature difference of 8—9° between the surface of the soil and that of the snow. Thus a sandy surface has a January-February temperature of c. ÷ 10°, while the surface below a snow-covering of 30—40 cm. has only a January-February temperature of ÷ 2°; at a depth of 40 cm the values are ÷ 6° and + 1° respectively.

Very convincing and thorough investigations on temperature conditions in snow have been made by J. Keränen (1920). The investigations comprise two snow-periods 1915—16 and 1916—17, the temperature in the surface of the snow at various depths and at the surface of the soil being measured 3 times daily, at 7 o'clock, at 13, and at 21 o'clock. By means of these figures the average monthly temperature for the respective depths has been calculated. The mean values for the two periods have been given in table 34, where likewise the depth of the snow-covering is given, besides the temperature of the air, and the temperature at various distances from the surface for the year and for each month.

The snow-covering during the months November—April has an average depth of 47.8 cm and due to this an average surface temperature of ÷ 14.2° can only cause the temperature at the bottom, i. e. at the surface of the soil to drop to ÷ 2.7°.

An investigation of temperature conditions in the snow in the various months will also show the varying isolation power of the

TABLE 34. **Annual Variations in the Temperature**

of the Air, Snow, and Soil in Sodankylä (Finland, 67° 22′ N., 26° 39′ E.). The investigations cover the period from November 1915 to October 1917 (cf. Keränen 1920, pp. 52—53).

	November—April	June—September	November	December	January	February	March	April	May	June	July	August	September	October	Average	Difference
th of snow cm	47.8	»	16.1	31.9	45.8	62.5	70.5	68.8	»	»	»	»	»	»	»	
ipitation mm	»	»	52.6	25.8	23.3	33.1	25.5	36.4	36.3	49.7	65.3	68.1	74.6	75.0	56.6	
ıds	»	»	8.2	7.9	8.1	7.7	6.3	7.9	7.8	6.9	7.0	8.0	7.1	8.8	7.6	
perature of r C°	÷12.1	10.6	÷8.2	÷*17.7*	÷14.0	÷15.0	÷13.6	÷4.1	1.2	11.9	**14.4**	11.7	4.5	÷1.2	÷2.5	
w 0 cm.....	÷14.2	»	÷9.6	÷18.9	÷16.1	÷17.0	÷15.1	÷5.9	*	»	»	»	»	»	»	
÷10 »	»	»	*	÷10.1	÷10.2	÷10.8	÷10.4	÷3.4	*	»	»	»	»	»	»	
÷20 »	»	»	*	*	÷ 7.2	÷ 8.2	÷ 8.2	÷3.0	*	»	»	»	»	»	»	
÷30 »	»	»	*	*	÷ 4.9	÷ 6.3	÷ 6.6	÷2.6	*	»	»	»	»	»	»	
÷40 »	»	»	»	*	*	÷ 4.8	÷ 5.4	*	*	»	»	»	»	»	»	
÷50 »	»	»	»	»	»	÷ 3.7	÷ 4.3	*	*	»	»	»	»	»	»	
÷60 »	»	»	»	»	»	»	÷ 3.4	*	*	»	»	»	»	»	»	
0 cm	÷ 2.7	13.2	÷2.8	÷ *4.0*	÷ 3.3	÷ 2.8	÷ 2.7	÷1.2	1.9	15.3	**18.3**	14.0	5.1	÷0.5	3.2	22.
10 »	÷ 1.9	12.2	÷1.1	÷ 2.5	÷ *2.6*	÷ 2.1	÷ 2.1	÷1.0	0.9	11.8	**16.7**	13.8	6.5	1.0	3.3	19.
25 »	÷ 1.4	11.0	÷0.4	÷ 1.7	÷ *2.1*	÷ 1.7	÷ 1.8	÷1.0	0.4	9.3	**14.9**	13.0	7.0	1.4	3.1	17.
40 »	÷ 1.1	10.7	0.4	÷ 1.2	÷ *1.8*	÷ 1.6	÷ 1.6	÷0.9	0.2	7.9	**14.3**	13.1	7.7	2.2	3.2	16.
80 »	÷ 0.1	9.0	1.3	0.6	÷ 0.2	÷ 0.6	÷ *1.0*	÷0.8	÷0.2	5.4	11.8	**11.9**	8.1	3.1	3.2	12.
120 »	0.8	7.2	2.4	1.3	0.6	0.3	0.1	÷*0.1*	0.0	1.9	8.4	**10.1**	9.5	4.6	3.2	10.
160 »	1.1	6.6	2.7	1.7	0.9	0.6	0.3	0.1	*0.1*	1.5	7.0	**9.4**	8.4	4.9	3.1	9.

snow. At the beginning of the winter when the snow lies lightly, a layer of a certain depth has a greater power of isolation than a layer of the same depth at the close of the winter, at which time the layer has grown more compact. Thus the table shows that the difference in temperature between corresponding layers is greatest at the beginning of a snow-period and decreases progressively until it attains its lowest value at the close of the winter. This fact has a certain practical significance in that the temperature at the surface of the soil will never be very much lower at the beginning of the winter than later on, in spite of the much slighter snow-covering at the beginning of the winter.

Investigations on the temperature conditions in soil with a different water content, of a different consistence, and with a different

TABLE 35. **Average Maxima, Minima, and Amplitudes** of various Soils. After Homén, 1897, pp. 47—48. The investigations cover the period 10—13 August 1893.

	Granite			Sandy heath			Bog		
	Max.	Min.	Diff.	Max.	Min.	Diff.	Max.	Min.	Diff.
Air temperature C° ...	22.7	9.6	13.1	»	»	»	»	»	»
Vegetable covering ...	32.5	12.6	19.9	37.7	6.4	31.3	32.8	2.2	30.7
0 cm	34.8	14.5	20.3	42.3	7.8	34.6	27.7	6.3	21.4
1 »	33.1	15.2	17.9	35.9	9.7	26.2	23.9	8.9	15.3
2 »	31.9	15.8	16.1	30.6	11.3	19.3	20.6	11.1	9.6
5 »	30.4	16.6	13.8	24.7	12.8	11.8	16.7	13.9	2.8
10 »	28.9	17.2	11.7	22.2	14.4	7.8	16.2	14.8	1.5
20 »	26.1	18.2	7.9	19.4	15.5	3.9	15.3	14.9	0.4
30 »	24.3	19.1	5.2	17.7	15.9	1.8	14.3	14.2	0.1
40 »	22.9	19.5	3.4	16.2	15.5	0.7	13.5	13.4	0.05
50 »	21.7	19.6	2.1	15.0	14.8	0.3	12.4	12.4	»
60 »	20.9	19.6	1.4	14.2	14.1	0.1	11.7	11.6	»

clothing of vegetation have been made in Finland by Th. Homén and described in a series of works (1894, 1896, and 1897). Tables 35, 36, and 37 give the chief data of these works. Table 35 comprises the daily heat maximum, heat minimum, and amplitude for granite, sandy soil, and boggy soil, respectively a solid, a loose, and a damp rock. The figures are the mean values of a series of investigations. Table 36 shows the daily amplitude for various kinds of soil, sandy soil, clayey soil, and boggy soil with or without wood or a covering of cultivated plants (cereals). Table 37 shows the annual mean temperature, the annual variation in temperature, i. e. the difference between the mean temperatures of the coldest and warmest months and the mean temperature of each month at different depths in soils with a different clothing of vegetation, thus at 0.5, 1.0, and 2.0 m for open grassfield, birchwood, and firwood.

A comparison between the temperature conditions of solid rock and loose sandy soil shows a much greater current of heat in the solid than in the loose soil. Taking the average of 4 days, the surface of a granite rock will be heated to 34.8° by day. The heat accumulated at the surface will comparatively rapidly spread downwards so as to make the temperature maximum at a depth of 60 cm no less than 20.9; for sandy soil the same figures are respectively

42.3 and 14.2. A comparison between the daily temperature amplitudes for rock and sandy soil shows, for the same depths, apart from the uppermost layers, a greater amplitude for the solid than for the loose soil. All these figures show that sandy soil is a better isolator than rocky soil.

TABLE 36. **Average Diurnal Variation of Temperature** in different Soils with differing Vegetation. After Th. Homén. Nos. 1—3 (1897, p. 48); 4—14 (1894, p. 231).

	Granite	Sandy heath	Bog	Sunny open heath		Forest-clad heath	
	10—13/8 1893	10—13/8 1893	10—13/8 1893	12—13/8 1892	6—8/9 1892	12—13/8 1892	6—8/9 1892
	1	2	3	4	5	6	7
0 cm depth..	20.2°	34.6°	21.4°	18.4°	22.0°	7.1°	6.3°
2 » » ..	16.1	19.3	9.6	13.0	13.2	4.3	3.6
5 » » ..	13.8	11.8	2.8	9.4	9.2	2.7	2.1
10 » » ..	11.7	7.8	1.5	6.4	6.2	1.5	1.3
20 » » ..	7.9	3.9	0.4	2.9	2.7	0.7	0.6
40 » » ..	3.4	0.7	0.05	0.6	0.4	0.2	0.1

	Sunny open bog		Forest-clad moor		Boggy field		Clayey field
	12—13/8 1892	6—8/9 1892	12—13/8 1892	6—8/9 1892	preserv. 12-13/8 1892	harvest. 6-8/9 1892	12—13/8 1892
	8	9	10	11	12	13	14
0 cm depth..	18.1°	14.7°	8.2°	7.4°	12.0°	18.6°	8.5°
2 » » ..	11.1	9.5	4.8	4.1	7.4	9.9	6.9
5 » » ..	4.4	3.9	1.9	1.7	3.6	4.7	4.0
10 » » ..	2.1	1.8	0.8	0.7	1.1	1.2	2.4
20 » » ..	0.5	0.5	0.2	0.2	0.3	0.3	1.0
40 » » ..	0.04	0.04	0.02	0.02	0.03	0.03	0.3

If, next, the dry soil, the sandy heath, is compared with the damp soil, the bog, the above-mentioned deviations are seen to be continual. The surface of the bog only attains a temperature maximum of 27.7°, owing to a great deal of heat becoming latent by evaporation of the water present in the bog. At a depth of 60 cm the maximum temperature is only 11.70. The minimum temperature of the surface is no less than 6.3° and is thus the lowest of the temperatures

of the three types of soil. Very striking is the daily variation in temperature, this is not only rather small at the surface, but already at very slight depths it is practically nil.

Table 36 shows the average daily variation in temperature for sandy soil, clayey soil, and boggy soil, with or without a covering of vegetation i. e. of cornfield or wood. These investigations show the same conditions as table 35, viz. that sandy soil has a greater daily variation of temperature than boggy soil at the same depth, and that the daily variation in temperature penetrates to greater depths in sandy than in boggy soil. If the soil is covered with vegetation, i. e. wood or cornfields, the result will be in the first place a decrease in the daily variation of temperature.

TABLE 37. **Annual Variation of Temperature**

in Soils with different Vegetable Covering in Heinäis, Finland.
After Th. Homén 1896, p. 147.

	January	February	March	April	May	June	July	August	September	October	November	December	Year	Difference
Firwood 0.50 m	1.6°	1.2	*1.0*	1.1	4.1	10.4	12.6	**12.8**	10.7	6.5	3.7	2.1	5.7	11.8
1.00 »	2.3	1.8	1.4	*1.3*	2.9	7.5	10.0	**11.0**	10.0	7.3	4.7	3.1	5.3	9.7
2.00 »	3.6	2.9	2.4	2.2	2.6	4.7	7.0	8.5	**8 7**	7.7	5.8	4.3	5.0	6.5
Birchwood 0.50 m	1.0°	0.4	÷*0.2*	0.3	2.3	7.5	10 2	**10.9**	9.4	5.6	3.0	1.6	4.3	11.1
1.00 »	2.0	1.5	1.0	*0.8*	1.8	4.9	3.4	**8.7**	8.4	6.3	4.3	2.9	4.2	7.9
2.00 »	3.5	2.9	2.6	*2 2*	2.3	3.9	5.7	7.0	**7.5**	6.8	5.6	4.4	4.5	5.3
Grassfield 0.50 m	1.1°	0.6	*0.3*	0.4	1.0	4.6	8.5	**9.8**	8.7	5.6	3.3	1.6	3.8	9.5
1.00 »	2.0	1.4	1.0	*0.9*	1.1	3.3	6.5	**8.1**	7.9	6.1	4.2	2.7	3.8	7.2
2.00 »	3.1	2.4	2·0	1.7	*1.6*	2.3	4.3	5.8	**6.4**	5.9	4.9	3.8	3.7	4.8

A similar series of investigations on annual variations in temperature and temperature conditions is only found respectively for sunny open and wooded sandy soil, but unfortunately not for damp soil, whether such as is constantly damp throughout the year, or such as is damp in winter but dry in summer Table 37 (after Homén 1896 shows the annual mean temperature at various depths for respectively sunny open and wooded soil, the mean temperature of each month and the difference between the lowest and highest

monthly mean temperatures. The table confirms the rule previously laid down that the amplitude decreases with the distance from the surface, and further that it is greatest for the sunny open soil, less for the wooded soil. This applies in still greater degree to the mean temperature of the warmest month and to the annual mean temperature. The sequence is as follows: grassfield → birchwood → firwood.

From a knowledge of the daily and annual variations in temperature it is possible to determine the heat-conducting power of a rock, this quantity being the less the slower the maximum and minimum spread in the soil, or the quicker the amplitude decreases downwards.

After Hann (1926, p. 800) we give the following values for a series of natural rocks (minute, cm.).

Sandstone	1.39
Clay with an admixture of sand	0.82
Sandy soil	0.52
Finnish granite	1.14
Heath	0.32
Boggy soil	0.13
Loose snow	0.16
Compact snow	0.24
Ice	0.68
Frozen earth	0.56
Earth not frozen	0.32

However, the heat-conducting power is not only different for the different rocks, it also varies in the same rock according to the air and water-content. The more solid and moist a rock is, the better is its heat-conducting power.

SUMMARY.

1. By investigations on the quantitative distribution of the life-forms in the floras, from temperate to progressively arctic regions, Raunkiær has shown that the chamæphyte percentage is subject to a steady increase from southern towards northern regions. Current conditions in the surrounding seas show an appreciable influence on the course of the individual Ch biochores, a warm northgoing current causing a decrease of the Ch percentage, while a cold southgoing current causes an increase of the Ch percentage. This appears plainly from conditions along the coasts of Greenland and Iceland.

2. If the Icelandic flora is divided into groups according to the northern and southern limits of the species, 7 species groups will result, distributed in 2 main groups. The 2 main groups represent species with respectively a northern and a southern distribution. The sub-groups within each main group differ from each other with respect to their northern limit. If the biological spectra of the individual groups are examined, a continued increase of the Ch percentage from the species group with the most southerly distribution to that with the most northerly distribution will be observed. If likewise the variation of the biological spectra and the species group spectra in the flora lists of the separate parts of the country and altitudinal zones is examined, the variation is the same in both cases, but greatest in the case of the species groups. Species groups and life-forms may thus be regarded as indicators of environment and may be made the basis of considerations on external factors where these are unknown.

3. Iceland's Ch percentage ranges it among the boreal hemicryptophyte-chamaephyte climates, the Ch percentage for the whole country being 15.2. The 20 p. c. Ch biochore for the country as a whole lies at a level of c. 300 m above the sea. Between this line and the snow-line, which lies at a level of c. 1200 m, it is possible

to distinguish between a series of zones, a lower and an upper highland zone, and a nival zone.

The lines between these zones can be drawn approximately as follows. The lower highland zone extends from the 300 m curve to the 600 m curve and has a Ch percentage of from 20 to 25; the upper highland zone extends from the 600 m curve to the 800 m curve and at its upper limit has a Ch percentage of 40; the nival zone is the zone between the 800 m curve and the snow-line; it has a Ch percentage of 40—50. Even though the position of the limits of the zones must be taken with some reservation, they agree well with conditions in the adjacent countries. Thus in Scotland the 20 p. c. Ch biochore lies at c. 800 m above sea-level, in the Faeroes at c. 500 m, in Greenland the 20 p. c. Ch biochore lies at the level of the sea in 60—61° N.

4. An investigation of the peculiarities of the flora in the separate parts of the country and the altitudinal zones shows that the differences are especially due to differences in temperature. The differences in the vegetation are likewise due to this factor.

The temperature of the soil differs according to the degree of snow-covering and water-covering, though in different ways. In the winter the geiri vegetation with its constant snow-covering as well as the flói vegetation with its constant water-covering are protected from the frost. Hence the result in both cases is a vegetation consisting principally of southern species, even though the two areas have not one species in common, while the snow-bare vegetation, melar and mosathembur, which is most exposed to the cold of winter, consists principally of arctic species, and the intermediate areas, mo, jaðar, and mýri, both as regards environment and biological conditions, occupy an intermediate position.

In the summer the flói vegetation has a constant covering of water, the specific heat and evaporating heat of which does not allow of so high a degree of heating as an equal amount of heat produces in the geiri vegetation. The result is, then, that a series of the most heat-loving species do not occur on water-covered soil, but only in the geiri. Soil with a constant water-covering is warm in winter, but cold in summer. The soil with a constant snow-covering in the winter is warm both summer and winter; both these circumstances are strikingly manifested in the composition of the vegetation.

The sequence dry, moderately moist, and moist soil, or mo,

jaðar, and mýri, handsomely illustrates the influence of the degree of moisture on the temperature of the surface. — The snow-covering is the same for the three types of vegetation, viz. the normal snow-covering of the country.

In winter the dry soil is exposed to the hardest frost, while the moderately moist and especially the moist soil are protected by the moisture of the earth. In the summer, the moist soil cannot, on account of its water content, attain as high a temperature as the dry and moderately moist soils. The last-mentioned is dry in summer, like the mo.

Since the moderately moist soil has the advantages of moist soil in the winter, and of dry soil in the summer, it must be the most favourable of these three types for southern plants. This will be confirmed by an examination of table 38.

Between dry and moist soils there is a peculiar difference. The dry soil, the mo, is relatively cold in winter but dry in summer, while the moist soil, the mýri, is relatively warm in winter and cold in summer. And, as a matter of fact, the result is that the mo has more high-arctic species requiring a low temperature and more species requiring higher temperature than the mýri. Conditions in still moister and still drier vegetations than mýri and mo, respectively, further confirm this difference.

The halla mýri is another case in point. Owing to the constant supply of ground-water this mýri becomes still warmer in winter and still colder in summer than the usual type, the fór mýri. And the result is a further reduction of the number of species requiring cold and, since the winter lasts longer than the summer, an increase of the species requiring warmth. The effect of the cold water in the summer on the composition of the vegetation is likewise appreciable.

Since in Iceland it is the temperature in winter and in Denmark the temperature in summer which determines the formation of the types of vegetation, the halla mýri vegetations of the two countries form a peculiar contrast. In Denmark the halla mýri is characterised by its high content of arctic plants, but in Iceland by its high content of southern plants. Even in Iceland, however, the cold water in the summer tends to give the vegetation an artic character.

Around the hot springs the vegetation consists exclusively of the species requiring most heat.

TABLE 38.

Species-group spectra and biological spectra of the different types of Vegetation on Iceland, based upon statistical investigations.

	Number of Localities examined	Points-sum	Number of species	Density of species	A	E	A 3	A 2	A 1	E 4	E 3	E 2	E 1	Ch	H	G	HH	Th
Mosathembur	11	2568	9	2.3	**83**	17	**70**	13	1	14	1	4	»	27	40	**33**	»	»
Melar	16	10658	24	6.8	**72**	28	**48**	18	6	24	4	0.5	0.1	**47**	41	11	»	2
Mo..............	34	43908	33	13.3	**53**	**47**	30	15	9	27	10	**9**	0.5	**31**	**52**	16	»	0.5
Jaðar	8	10140	39	13.2	**47**	**53**	23	14	10	31	12	**10**	0.1	18	**53**	**28**	1	1
Formýri	18	15240	26	9.4	**49**	**51**	22	18	9	**38**	12	1	»	**24**	21	**49**	5	0.2
Hallamýri.........	5	4180	25	8.3	**44**	**56**	17	**22**	5	25	**21**	**11**	»	8	28	**58**	6	1
Flói	9	1740	4	1.9	28	**72**	5	3	**20**	**37**	**36**	»	»	2	13	**76**	**10**	»
Geiri	15	15374	27	11.0	37	**63**	**23**	10	4	**24**	**26**	**13**	1.1	**34**	**50**	16	»	0.1
Forest undergrowth	6	5592	33	8.6	28	**72**	14	10	4	**22**	**37**	**11**	**3**	12	**72**	16	»	»
Subularia flag.....	2	404	5	2.0	14	**86**	14	»	»	21	**65**	»	»	»	11	18	»	**71**
Flag..............	5	4852	25	9.9	**58**	**42**	**38**	**19**	»	15	25	1.4	0.1	13	**60**	12	»	**15**
Valllendi	6	4092	18	6.9	25	**75**	16	0.3	9	20	18	**36**	2	13	**67**	20	»	1

5. The low temperature in winter being the factor which has the greatest bearing on the vegetation, a natural system of the Icelandic types of vegetation, i. e. a system in which the factors are given in the order of their degree of importance for the vegetation, must give as the first principle of division the conditions of snow-covering, as the next, the conditions of moisture, and so forth.

Hence, the types of vegetation investigated in this treatise must be ranged in the following order.

I. Vegetation bare of snow.

- 1. Soil covered with moss — Mosathembur (moss heath, Grimmia heath)
- 2. Soil covered with gravel — Melar (fell field)

II. Vegetation with normal snow-covering.

- 1. Soil dry — Mo
- 2. Soil moderately moist
  - a. Soil covered with vegetation, level — Valllendi
  - b. Soil covered with vegetation, knolly — Jaðar (grass mo)
  - c. Soil bare, with smallknolls — Flag (clayey flats)

3. Soil moist	Mýri
a. Stagnant water	Fór mýri (swampy mýri)
b. Running water	Fét mýri
c. Springs	Halla mýri
4. Soil always covered with water	
a. Stagnant water	Flói
b. Running water	Fén
c. Springs	Dý
III. Vegetation with a constant and deep snow-covering	
1. Normal light conditions, no leaf-fall	Geiri (snow patch)
2. Shade and leaf-fall	Forest ground

6. Of the individual types of vegetation the following may be mentioned.

The mosathembur vegetation is bare of snow in the winter. The surface is covered with a dense and thick carpet of moss in which there occurs a scattered vegetation of high arctic plants poor in species. The amount of geophytes is unusually large. As a climatically conditioned type the mosathembur vegetation is confined to the North Atlantic region, in Iceland to the higher levels of South Iceland and especially East Iceland.

The melar vegetation is likewise bare of snow in the winter. The surface is covered with gravel and is dry, with polygonal formation or solifluction. The vegetation is open, but with a relatively high number of species and density.

The mo vegetation, in point of environment, is characterised by a normal snow-covering and by the fact that it is unaffected by the ground water. The surface is knolly and covered with vegetation. The vegetation is both rich in species and dense, and consists of an equal mixture of arctic and southern plants which are either Ch or hemicryptophytes.

The jaðar vegetation like the mo has a normal snow-covering but is confined to moderately moist soils, i. e. soils dry in summer and wet in winter. The surface has large knolls and is covered with a dense vegetation rich in species (both the number and density of species attain their maximum in jaðar). The vegetation consists of an equal mixture of arctic and southern species, though compared with the adjacent types the southern species attain a relative maximum here. H are the dominant life-form, attaining their

maximum development in jaðar. Ch are of slight importance, while the number of G is on the increase.

The valllendi vegetation is a variant developed on the cones deposited by the streamlets of melting snow. There is no knoll formation and the vegetation is that of a more southern environment.

The flag vegetation. The surface is a bare clayey flat with scattered knolls and stones. The vegetation is characterised by its high therophyte percentage, though in jaðar, too, Th attain a relative though small maximum. Arctic species are more dominant in flag than in jaðar or especially valllendi. The jaðar vegetation seems to be confined to the Icelandic lowlands, to the jaðar or the transition from mo to mýri.

The mýri vegetation is peculiar to moist soil which must not, however, be covered with water all the year round. The surface is knolly. Here the vegetation likewise consists of an equal mixture of arctic and southern plants, but the most arctic and the most southerly either do not occur or their number is much reduced compared with that of mo and jaðar. G are the dominant life-form, Ch attain a relative maximum, while the number of H is much diminished. The number and density of the species are appreciably less than in mo and jaðar.

The types of mýri occurring in Iceland are as follows.

Fór mýri, which develops in depressions with stagnant water.

Halla mýri, which develops in places where the ground water comes to the surface, thus especially at the foot of mountains.

Fét mýri, which occurs near running water, along the banks of rivers, near the sea etc.

The flói vegetation develops where the soil is constantly covered with water all the year round. The surface is level, without knolls. The vegetation is very scattered and poor in species and consists almost exclusively of southern plants. The dominant life-form is G. The hydrophytes or helophytes likewise attain their maximum development in the flói.

The geiri vegetation is confined to soil with a constant and deep snow-covering from early autumn to late spring. The surface is always level, without knolls. The vegetation consists principally of southern plants, notably those requiring the highest temperature which are found in greatest quantity here. The dominant life-form is H, of less importance are Ch and especially G. Both the number and density of species are relatively high, though less than in the mo.

The forest ground vegetation resembles the geiri vegetation in external factors and in its main features. The density, the number of high-arctic plants, and the quantity of Ch are less in forest ground than in geiri, while the quantity of H is higher. The cause for this may perhaps be found in the differing illumination and the more constant protection from frost in the forest ground than in the geiri.

Each of the types of vegetation discussed above comprises a great number of formations which have not, as yet, been more closely examined.

7. Our knowledge of the quantitative distribution of the individual types of vegetation in the various parts and altitudinal zones of Iceland is as yet rather deficient. Of the percentage of types in the individual altitudinal zones, the following particulars may be given.

I. In the lowlands, below the 20 p. c. Ch biochore, the 300 m curve, the dominant features of the landscape are forest, mo (especially heather mo), jaðar, littoral meadow, flag, mýri (fór mýri, halla mýri, and fét mýri), flói, dý and fén, and lowland melar.

II. In the lower highland zone, 300—600 m above sea-level, the types of vegetation are melar (highland melar), mosathembur, mo (level and knolly), jaðar, mýri (fór mýri), flói, dý, and geiri (including the Salix herbacea and the Sibbaldia vegetation).

III. In the upper highland zone the vegetation is either melar or geiri (especially Anthelia crusts).

IV. In the zone between the 800 and 1200 m curves, the nival zone, a very scattered melar vegetation is recorded. The larger or smaller accumulations of snow are another feature of the landscape. Above the 1200 m curve, the snow line, we come to the

V. zone, the jökulls, where all higher vegetation is excluded on account of the continuous snow-covering.

The forces that go to form the various types of vegetation are, in the lowlands, especially the differences in moisture, in the highlands, the differences in snow-covering.

8. The investigation of the distribution of species, species-groups, and life-forms in the formations according to increasing prevalence of one and the same external factor has brought to light the following facts.

In a given scale of one and the same external factor the individual species attain maximum frequency, i. e. minimum distance between individuals, at some point in the scale. Passing from this point towards either greater or less prevalence of the factor under

consideration, the frequency of the species gradually decreases, i. e. the distance between individuals grows greater and greater and at last the species entirely disappears. This applies to all species. The individual species may be distinguished with respect to the position of the maximum in the scale, the magnitude of the maximum, and the number of degrees in the scale which the species covers.

The proportional distribution of the species in a given scale has proved the same wherever it has been more closely investigated.

The distribution of Raunkiær's life-forms in the scale of external factors is the same as that of the individual species. The sequence of the maxima of the life-forms in the scale of moisture from the most moist to the driest section is as follows: HH → G → H → Ch → (Th). This sequence occurs wherever conditions have been closely examined and remains the same whether the succession is determined by means of the number of individuals (frequency sum) or the number of species.

In the scale of snow-covering, Ch occur in greatest quantity in the "sections devoid of snow", H in the opposite sections. These conditions are repeated wherever the facts have been investigated, and remain the same whether calculated by means of the number of individuals or by means of the number of species.

The distribution of the species groups in the scales of external factors would seem to open up new possibilities of determining the factors which are active in the distribution of plants.

Fig. 1 is to be found on page 21, the others are printed on plates I—XII.

LITTERATURE

Alcenius, O., Finlands kärlväxter, Helsingfors 1919.

Anderson G. og H. Hesselman, Verzeichnis der in König Karls Land während der swedischen Polarexpedition 1898 gefundenen Phanerogamen. — Öfvers. kgl. Vetensk.-Akad. Förhandl, Stockholm 1898.

— — Bidrag till kännedomen om Spetsbergens och Beeren Eilands kärlväxtflora. — Bihang till K. Svenska Vet.-Akad. Handl. 1898.

Ascherson, P. & P. Graebner, Flora des Nordostdeutschen Flachlandes (ausser Ostpreussen). Berlin 1898—99.

Asplund, Erik, Beiträge zur Kenntnis der Flora des Eisfjordsgebietes. — Ark. f. Botanik, Bd. 15, Nr. 14, 1919.

Blytt, A., Die Theorie der wechselnden kontinentalen und insularen Klimate. — Engl. Bot. Jahrb. 2: 1—50, 177—184, 1882.

— Haandbog i Norges Flora. — Kristiania 1906.

Botany of the Færöes, Vol. I—III, Copenhagen 1901—08.

The Botany of Iceland, Vol. I—II, Copenhagen 1912—20.

Ferdinandsen, C., Undersøgelser over danske Ukrudtsformationer paa Mineraljorder. Kbhvn. 1918.

Fries, Thore C. E., Den synekologiska Linjetaxeringsmetoden. — Flora och Fauna, 1919.

Grönlund, Chr., Islandske Naturforhold med særligt Hensyn til Mosvæxtens Betydning for Landskabet. — Tidsskr. f. populære Fremstillinger af Naturvidenskaben 5. R. IV.: 321—356. 1877.

— Islands Flora. Kbhvn. 1881.

— Karakteristik af Plantevæksten paa Island, sammenlignet med Floraen i flere andre Lande. — Naturhist. Foren. Festskr. 1884: 107—145.

Grøntved, Johs., Formationsstatistiske Undersøgelser paa nogle danske Overdrev. — Bot. Tidsskr. 40: 1—71, 1927.

Hann, Julius, Handbuch der Klimatologie, Bd. III. 1911.

— Lehrbuch der Meteorologie, 4. Aufl. 1926.

Hartz, N., Botanisk Rejseberetning fra Vest-Grønland 1889—90. — Medd. om Grønland 15: 1—60, 1894.

— Østgrønlands Vegetationsforhold — Medd. om Grønland 18: 107—314, 1895.

— Fanerogamer og Karkryptogamer fra Nordøst-Grønland, c. 75—70° n. Br. og Angmagsalik, c. 65° 40′ n. Br. — Ibid. 18: 315—393, 1895.

— and Chr. Kruuse: The Vegetation of Northeast Greenland, 69° 25′ lat. n. — 75° lat. n. — Ibid. 30: 333—431, 1911.

Hesselbo, Aug., The bryophyta of Iceland. — The Botany of Iceland, Vol. I: 395—678, 1918.

Homén, Theodor, Bodenphysikalische und meteorologische Beobachtungen mit besonderer Berücksichtigung des Nachtfrostphaenomens. — Bidrag til kännedom af Finlands natur och folk 54: 187—416, 1894.
— Ueber die Bodentemperatur in Mustiala. — Acta Soc. Scient. Fennicae, XXI, 9, 1—183, 1896.
— Der tägliche Warmeumsatz im Boden und die Wärmestrahlung zwischen Himmel und Erde. — Ibid. XXIII, 3, 1—148, 1897.
Hooker, J. D., The Students Flora of the British Islands. 1884.
Jessen, Knud, Oversigt over Karplanternes Udbredelse i Danmark. — Bot. Tidsskr. 39: 137—210, 1926.
Jónsson, Helgi, Studier over Øst-Islands Vegetation. — Bot. Tidsskr. 20: 17—89, 1895.
— Vegetationen paa Snæfellsnæs. — Vid. Medd. Naturh. Foren. 1900: 15—98.
— Vegetationen i Syd-Island. — Bot. Tidsskr. 27: 1—82. 1905.
Keränen, J., Ueber die Temperatur des Bodens und der Schneedecke in Sodankylä. — Ann. Ac. Fennicae 13. 1920.
Klinge, Joh., Flora von Est-, Liv- und Curland. Reval 1882.
Kruuse, C., Vegetationen i Egedesminde Skjærgaard. — Medd. om Grl. 14: 348—399, 1898.
— List of the phanerogams and vascular cryptogams found on the coast 75°—66° 20′ lat. N. of East-Greenland. — Medd. om Grønland 30: 143—208, 1905.
— List of Phanerogams and Vascular Cryptogams found in the Angmagsalik District on the East coast of Greenland between 65° 30′ and 66° 20′ lat. N. — Medd. om Grl. 30: 219—287, 1806.
Lange, Joh., Conspectus Florae Groenlandicae, I—II. — Medd. om Grl. 3, 1880—1887.
Lindman, C. A. M., Svensk Fanerogamflora. Stockholm 1918.
Lynge, B., Vascular plants from Novaya-Zemlya. — Rep. Scient. Result. Norv. Exped. Novaya—Zemlya 1921. Nr. 13. 1923.
Melan, A. J., Suomen Kasvio. 1906.
Mentz, A., Danske Græsser og andre græsagtige Planter. Kbhvn. 1902.
— Studier over danske Mosers recente Vegetation. Bot. Tidsskr. 31, Kbbvn. 1912.
More, A. G., Contributions towards a Cybele Hibernica. 1898.
Nathorst, A. G., Nya bidrag till kännedomen om Spetsbergens kärlväxter, och dess växtgeografiska förhållanden. — Kgl. Svenska Vetensk. Akad. Handl. Bd. 20, Nr. 6. 1883.
Norman, J. M., Norges arktiske Flora, I—II. Kristiania 1894—1901.
Olsen, Carsten, Vegetationen i nordsjællandske Sphagnummoser. — Bot. Tidsskr. 34: 1—44, 1914.
— Studier over Jordbundens Brintionkoncentration og dens Betydning for Vegetationen særlig for Plantefordelingen i Naturen. Kbhvn. 1921.
Óskarsson, Ingimar, Botaniske Undersogelser fra Islands nordvestlige Halvo, Vestfirðir. — Bot. Tidsskr. 39: 401—445, 1927.
Ostenfeld, C. H., Skildringer af Vegetationen paa Island. — Bot. Tidsskr. 22: 227—253, 1899; ibid. 27: 111—122, 1905.
— Phanerogamae and Pteridophyta. — Bot. Færöes, Vol. I, 1901.
— and O. Gelert, Flora arctica I Pteridophyta, Gymnospermae and Monocotyledones. Kbhvn. 1902.
— Plantevæxten paa Færoerne med særlig Hensyntagen til Blomsterplanterne. Kbhvn. 1906.

Ostenfeld, C. H., and Andr. Lundager, List of vascular plants from North-East Greenland (N. of 76° n. lat.) collected by the Danmark Expedition. — Medd. om Gronland 43: 1—32, 1910.

— Plants collected during the first Thule expedition to northern most Greenland. — Ibid. 51: 371—381, 1915.

— Flowering plants and ferns from Wolstenholme Sound (ca. 76° 30' N. Lat.) — Ibid. 64: 189—206, 1923.

— Two plant lists from Inglefield Gulf and Inglefield Land (77° 28' and 79° 10' N. Lat.), N. W. Greenland. — Ibid. 64: 207—214, 1923.

— The Vegetation of the North-coast of Greenland based upon the late Dr. Th. Wulff's collections and observations. — Ibid. 64: 221—268, 1923.

— Flowering Plants and Ferns from North-western Greenland collected during the Jubilee Expedition 1920—22 and some Remarks on the Phytogeography of North Greenland. — Ibid. 68: 1—42, 1925.

— The Flora of Greenland and its Origin. — Biol. Medd. Kgl. D. vid. Selsk., VI, 3, 1926.

Porsild, Morten P., Bidrag til en Skildring af Vegetationen paa Øen Disko. — Medd. om Grl. 25: 89—307, 1902.

— The Flora of Disko Island and the adjacent coast of west Greenland from 66°—71° N. Lat. — Ibid. 58: 1926.

Ramann, E., Bodenkunde. 3. Aufl. 1911.

Raunkiær, C., Vesterhavets Øst- og Sydkysts Vegetation. — Festskrift i Anledning af Borchs Kollegiums 200-Aars Jubilæum pag. 312—362, Kbhvn. 1889.

— Dansk Ekskursions-Flora. 3. Udg. Kbhvn. 1914.

— Planterigets Livsformer og deres Betydning for Geografien. Kbhvn. 1907.

— Livsformernes Statistik som Grundlag for Biologisk Plantegeografi. — Bot. Tidsskr. 29: 42—83, 1908.

— Formationsundersøgelse og Formationsstatistik. — Ibid. 30: 20—132, 1909—10.

— Det arktiske og antarktiske Chamaefytklima. — Biol. Arbejder tilegn. Eug. Warming, pag. 7—27, 1911.

— Formationsstatistiske Undersogelser paa Skagens Odde. — Bot. Tidsskr. 33: 197—243, 1912.

— Measuring-apparatus for statistical investigations of plant-formations. — Bot. Tidsskr. 33: 45—48, 1912.

— Om Valensmetoden. — Ibid. 34: 289—311, 1916.

— Recherches statistiques sur les formations végétales. — Biol. Medd. Vid. Selsk. I, 3, 1918.

— Ueber das biologische Normalspektrum. — Ibid. I, 4, 1918.

— Erindringsord til Forelæsninger over Plantegeografi. Kbhvn. 1920.

Resvoll-Holmsen, H., Observations botaniques. — Exploration des nord-ouest du Spitsberg entreprise sous les auspices de s. a. s. le prince de Monaco par la mission Isachsen V. — Résultats des campagnes scientifiques accomplies sur son yacht par Albert I. prince souverain de Monaco. Fasc. XLIV, 5, 1—81, Monaco 1913.

— Om Vegetationen ved Tessevand ved Lom. — Videnskapsselsk. Skr. I, Kristiania 1912.

— Statistiske Vegetationsundersogelser fra Maalselvdalen i Tromsö Amt. — Ibid. 1913.

— Statistiske Vegetationsundersogelser fra Foldalsfjeldene. — Ibid. 1914.

Resvoll-Holmsen, H., Om Fjeldvegetationen i det ostenfjeldske Norge. — Archiv f. Math. og Naturvidensk. 37, Kristiania 1920.
Rosenvinge, L. Kolderup, Andet Tillæg til Gronlands Fanerogamer og Karsporeplanter. — Medd. om Grl. 3, 1892.
— Det sydligste Grønlands Vegetation. Ibid. 15: 73—250, 1896.
Samsoe-Lund, Vejledning til at kjende Græsser i blomsterlos Tilstand. Kbhvn. 1882.
Schouw, Joakim, Frederik, Grundtræk til en almindelig Plantegeografi. Kbhvn. 1822.
Simmons, Herman G., The vascular plants in the flora of Ellesmereland. — Report of the second norwegian arctic expedition in the »Fram« 1898—1902. Nr. 2. Kria. 1906.
— A survey of the Phytogeography of the arctic american Archipelago with some notes about its exploration. — Lunds Universitets Årsskrift 1913.
Smith, H., Vegetationen och dess utvecklingshistoria i det centralsvenska högfjällsomraadet. — Uppsala 1920.
Stefánsson, St., Fra Islands Væxtrige II. — Vid. Medd. D. Naturh. Foren. 1894: 174—212, 1895.
— Flóra Íslands. Kbhvn. 1901. 2. Udg. 1924.
Sälan, Th., A. Osw. Kihlman, Hj. Hjelt, Herbarium musei Fennici I. Plantae vasculares. Helsingfors 1889.
Tansley, A. G., Types of British Vegetation. Cambridge 1911.
Thorkelsson, Thorkel, Um úrkomu á Íslandi. — Búnaðarrit. XXXVIII. Reykjavík.
Thoroddsen, Th., An Account of the Physical Geography of Iceland with special reference to the plant life. — The Botany of Iceland I, 187—343, 1914.
Vahl, M. og G. Hatt, Jorden og Menneskelivet, I. 1922.
Warming, Eug., Om Gronlands Vegetation. — Medd. om Grl. 12: 1—245, 1888.
— Plantesamfund. Grundtræk af den okologiske Plantegeografi. Kbhvn. 1895.
Watson, H. C., Topographical Botany. 1883.
Wild, H., Ueber die Differenzen der Bodentemperaturen mit und ohne Vegetations- resp. Schneedecke. — Mém. Acad. St. Petersb. VIII. Ser. Vol. V, Nr. 8, 1897.
Willis, J. C. og J. K. Burkil: The phanerogamic flora of the Clova mountains. — Transact. Bot. Soc. Edinburgh 22: 109—125, 1901—04.

PLATES I–XII

Fig. 2. Lýngdalur with Hrólfshólar.

In the foreground mo vegetation, further back some narrow strips of mo with mosathembur (the lighter areas). In the background Hrólfshólar with alternating areas of melar and mo. In the depression in centre, a mýri.

Fig. 3. Thrasaborgir.

The light areas in the foreground are mosathembur, in centre, a large patch of snow, geiri, with level surface. The knolly parts between geiri and mosathembur are mo. The picture is taken from the south, looking due north.

Fig. 4. The Mosathembur Vegetation on Lýngdalsheiði.
The thick carpet of moss is intersected by long narrow fissures with a special vegetation.
The composition of the vegetation is shown in table 9 A, p. 40.

Fig. 5. The Melar Vegetation on Lýngdalsheiði.
The bottom is covered with gravel containing scattered stones. In the background Kalfstindar.
The composition of the vegetation is shown in table 10 A, p. 44.

Fig. 6. The Mo on Lýngdalsheiði.
The ground with pronounced knolls. For vegetation, see table 11 A, pp. 48–49.

Fig. 7. Mo on the western Side of Lýngdalur.
The knolls on the slope are different from (more elongated than) the knolls on level ground.

Fig. 8. The Valllendi Vegetation on Lýngdalsheiði.
Surface level, without knolls. For vegetation see table 12 A, p. 52.

Fig. 9. Patch of Snow from the western Side of Lýngdalur.
The surface of the snow patch is level in contrast to the knolly surface of the sourrounding mo. For vegetation see table 13 A, pp. 56—57.

Fig. 10. Patch of Snow on Lýngdalsheiði.
Altitude c. 300 m. The picture shows the snow patch distinctly marked off from the sourrounding mo.

Fig. 11. Mýri at Björk.
Surface knolly. For vegetation see table 15 A, pp. 66—67.
In the background Lýngdalsheiði and the Björk Farm.

Fig. 12. Flag Mo at Lækjamót.

The picture shows the surface of the flag mo covered with small knolls in contrast to the larger knolls of the mo (left), and the sharp line of demarcation between flag and mýri (right). For the composition of the vegetation see table 17 A, pp. 72—73.

Fig. 13. A smaller Section of fig. 12.

The surface features, the bare clayey ground with small grass knolls and stones, are more distinct.

Fig. 14. Forest Glade at Norðtunga.
For the composition of the vegetation see table 21 A, pp. 90—91.

Fig. 15. Melar from the Crest of a Hill on Arnarvatnsheiði.
The surface covered with larger or smaller stones without solifluction curves.
For vegetation see table 22 A, 1—6, pp. 104—105.

Figs. 16—17. Melar from a Slope,

viewed from above (fig. 16) and from below (fig. 17). The solifluction curves are much more conspicuous in the latter than in the former view. Vegetation practically the same as above, see table 22 A, 1—6, pp. 104—105.

Fig. 18. The Betula nana-Mo on Arnarvatnsheiði.
Surface covered with vegetation but without knolls. For the composition of the vegetation see table 22 A, 7—11, pp. 104—105.

Fig. 19. The knolly Mo on Arnarvatnsheiði.
Surface knolly. For the composition of the vegetation see table 23 A, 1—5, pp. 107—108.

Fig. 20. The Jaðar Vegetation on Arnarvatnsheiði.
Surface covered with large knolls and a vegetation the composition of which is shown in table 23 A, 6—10, pp. 107—108.

Fig. 21. Picture of a Depression with Mýri on Arnarvatnsheiði.
The varied composition of the highland mýri is illustrated by the collections of water. For vegetation see table 24 A, p. 112.

Fig. 22. A portion of the Flói on Arnarvatnsheiði shown in fig. 21.
Surface without knolls. For vegetation see table 23 A, p. 112.

Fig. 23. Strip of Snow Patch, on the north aspect of a hill.
In contrast to the formations above and below, the surface is comparatively level.
For vegetation see table 25 A, 5, pp. 116—117.

Fig. 24. Large Patch of Snow on Arnarvatnsheiði.
Surface level, the vegetation differs on the bottom and sides of the snow patch.
See table 25 A, pp. 116—117.

Fig. 25. A portion of the Patch shown in fig. 24.
Geranium silvaticum in bloom.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **IX**, 2.

THE SPECIES OF THE GENUS LARIX AND THEIR GEOGRAPHICAL DISTRIBUTION

BY

C. H. OSTENFELD AND C. SYRACH LARSEN

WITH 35 ILLUSTRATIONS AND 8 MAPS

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI A/S
1930

Arbejder fra den botaniske Have i København. Nr. 117.

Det Kgl. Danske Videnskabernes Selskabs videnskabelige Meddelelser udkommer fra 1917 indtil videre i følgende Rækker:

Historisk-filologiske Meddelelser,
Filosofiske Meddelelser,
Mathematisk-fysiske Meddelelser,
Biologiske Meddelelser.

Hele Bind af disse Rækker sælges 25 pCt. billigere end Summen af Bogladepriserne for de enkelte Hefter.

Selskabets Hovedkommissionær er *Andr. Fred. Høst & Søn*, Kgl. Hof-Boghandel, København.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **IX**, 2.

THE SPECIES OF THE GENUS LARIX AND THEIR GEOGRAPHICAL DISTRIBUTION

BY

C. H. OSTENFELD AND C. SYRACH LARSEN

WITH 35 ILLUSTRATIONS AND 8 MAPS

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI A/S
1930

Arbejder fra den botaniske Have i København. Nr. 117.

I. Introduction.

In the course of an excursion undertaken in 1922, the eldest among us saw some larch plantations in Roden Forest, in the south-east of the Danish island of Lolland; in most respects they resembled the Japanese Larch (*Larix Kaempferi*), but differed, nevertheless, from it in several respects, and therefore aroused my interest[1]. This was the cause of my endeavouring to obtain information regarding, and material from, various larch plantations in this country, for the purpose of ascertaining which forms and species we had taken into culture during the course of the past decades. Arising out of these enquiries, my interest became extended to embrace the whole genus Larix, one result being the present treatise, which considers only the larch in the wild state, and its geographical distribution. It is founded upon a comprehensive study of material from various parts of the globe, as well as of the very copious literature extant upon the subject. Duties of many kinds make heavy demands upon my time, and I have taken as collaborator Mr. C. Syrach Larsen, Graduate of Forestry, to whose interest and industry I am indebted, that this paper could be presented in such detail.

We have received assistance from many different quarters; we have had material on loan from the Arnold Arboretum in Massachusetts, where the East-Asiatic species are very well represented. Moreover, the Larix material in the museums at Washington, New York, Ottawa, Kew and London, as well as that in the Gray Herbarium of Cambridge, Mass.,

[1] It is *L. Gmelini*, var. *olgensis*. See p. 55.

has been examined by Ostenfeld on the occasion of his visits to those cities; and the collection of the late Professor Henry in Dublin has been studied by Syrach Larsen, as well as those at Kew and the British Museum. Material has further been placed at our disposal by the kindness of Professor Szafer in Krakow, Professor B. Fedtschenko and Professor Sukatschew in Leningrad, and, finally, we have, of course, made use of the museum-collection at the Botanical Gardens here in Copenhagen. Ostenfeld has personally seen *L. laricina* and *L. Lyallii* on the spot in Canada, and *L. decidua* in the Alps, while Syrach Larsen has studied the various forms of larch cultivated in England from early times, as well as Mayr's cultures in Grafrath. We have been fortunate in having been able to make use of the original material of most of the species or varieties described in recent times, namely: *L. Mastersiana*, *L. sinensis* (= *L. Potanini*), *L. olgensis* (= *L. Gmelini* var. *olgensis*), *L. Griffithiana*, *L. occidentalis*, *L. Lyallii*, *L. coreensis* (= *L. Gmelini* var. *olgensis*), as well as *L. pendula* (= *L. decidua* × *laricina*), and specimens from the original localities of *L. Principis Rupprechtii* (= *L. Gmelini* var. *Principis Rupprechtii*), and *L. alaskensis* (*L. laricina*), so that we have been enabled to arrive at very fairly definite conclusions with regard to the conception of the species and their more important varieties.

In addition, we have received support from various quarters connected with forestry in this country, numerous owners of woods, and foresters having sent us material; similarly, the director of the Danish Experimental Forestry Service, Professor Dr. A. Oppermann, has kindly allowed us to make use of his valuable collection of larches in the Nursery Gardens at Egelund, and has, moreover, evinced warm interest in our work. We have also received

great assistance from the Scottish Department of Forestry, Mr. J. M. MURRAY having on several occasions sent us important material of the Larix species cultivated in Scotland. In this paper, however, as said above, we have restricted ourselves to laying particular stress upon the wild-growing larches, that is to say, the genus Larix as it occurs in nature, and have in most cases deferred the treatment of the cultivated forms.

We take this opportunity of expressing our gratitude to all those who, in one way or another, have assisted us in our labours.

Two maps and a very short summary of some of the results of the results of the present paper were published by us in "Die Pflanzenareale 2. Rh. Heft 7. 1930", as Karte 62—64.

II. Larix, Miller.

Larix, Miller, is a very well-defined genus. It differs from all the other genera of *Pinaceae* in being deciduous, and in the dwarf as well as the long shoots being provided with green leaves. Only its near relative, *Pseudolarix*, also has deciduous leaves, but the latter differs in possessing cones, which drop their scales at maturity.

The genus is only found in the northern hemisphere, in the southern part of which it only occurs spontaneously in mountainous regions, while towards the north, and particularly in the Arctic regions, it goes down to the lowlands, where it forms extensive forests.

The genus is divided into 10 species and three varieties, some of which are but little known even to-day.

They may be classified as follows: —

Key to the Species and Varieties of Larix.

I. Bracts longer than the cone-scales. Leaves slightly or strongly keeled on both sides; the upper-side may, in exceptional cases, be without keel.

A. Bracts reflexed.

a) Bracts much longer than the cone-scales. The cone 5—11 cms. long..... 1. *L. Griffithiana.*

b) Bracts only slightly longer than the cone-scales. The cone 3—5 cms. long. 2. *L. Mastersiana.*

B. Bracts straight or slightly recurved.

a) The cone long and narrow; length to breadth 1,4—1,7; Bracts 0—2 mm. longer than the cone-scales. Leaves deeply keeled on the under-side; slightly less keeled on the upper-side, 1,5—3 cms. long............ 3. *L. Potanini.*

b) The cone short and broad. Length to breadth 1—1,5, leaves 2,5—4 cms.

1. The leaves are more strongly keeled on the upper- and under-sides than in the case of any other species. The young shoots are particularly densely pilose. The cone 3,5—5 cms. long. Bracts straight .... 4. *L. Lyallii.*

2. The leaves keeled on the under-side only. The young shoots at first somewhat pilose, finally smooth. The cone 2,5—3 cms. long. The bracts straight or slightly recurved.................. 5. *L. occidentalis.*

II. Bracts shorter than the cone-scales. Leaves not keeled on the upper-side and frequently flat.

A. The cone-scales reflexed. The leaves broad, deeply keeled on the under-side. Both sides provided

with stomata. The young shoots stout, and of reddish-brown colour . . . . 6. *L. Kaempferi.*

B. The cone-scales straight or somewhat concave. The leaves flat, or slightly keeled on the under-side.

a) The cone-scales distinctly concave.

1. Cones 1,5—2 cms. long. The cone-scales smooth, often shining . . . . 10. *L. laricina.*
2. Cones narrow, 3—4 cms. long. The scales pilose, most frequently strongly so on the outer-side of the basal portion; dull. . . . . 8. *L. sibirica.*

b) The cone-scales straight.

1. Cones 2,5—4 cms. long, narrow. The scales dull, the free edges evenly rounded or slightly emarginate. The bracts are of the same light colour as the cone-scales, which are smooth or pilose on the outer side. The cone is compact. The scales open only sligthly when ripe . . 9. *L. decidua.*

   var. *polonica.* The cone is more frequently smaller, shorter, and thicker. The free edges of the cone-scales are more rounded, and often pilose on the outer-side.

2. The cones up to 2 cms. long; broad. The free edges of the cone-scales are truncate or emarginate. The bracts are darker in colour than the light-coloured, shining, cone-scales. The cone-scales are most frequently smooth on the outer-side, but may be slightly pilose. The cones as a whole

are of an open, characteristically light construction. The cone-scales open widely when ripe .... 7. *L. Gmelini.*

var. *olgensis.* The cone longer and more cylindrical. The free edges of the cone-scales are rounded or truncate. The usually straight cone-scales may also be slightly concave or slightly recurved. The first year's shoots are more frequently pilose, very often extremely so.

var. *Principis Rupprechtii.* The cone is still longer and more cylindrical than in the case of the former variety; length up to about 4 cms.

The areas of distribution for the various species differ very considerably in extent; the species with restricted areas of occurrence being indigenous towards the south, particularly in Asia, and appear at the same time to be the oldest forms. Some of the other species have very large areas of occurrence.

III. The Species of Larix.

1. **L. Griffithiana** (Lindl. & Gordon, *1850*), Carrière: Traît. Conif. *1855*, p. 278. —

Gordon: Pin. 1858, p. 126. — Willkomm: Forstl. Fl. 1887, p. 157. — Rehder: Man. Trees and Shrubs, 1927, p. 51. —

Syn:

Abies Griffithiana, Lindley & Gordon, in Journ. Hort. Soc. V. 1850, p. 214. —

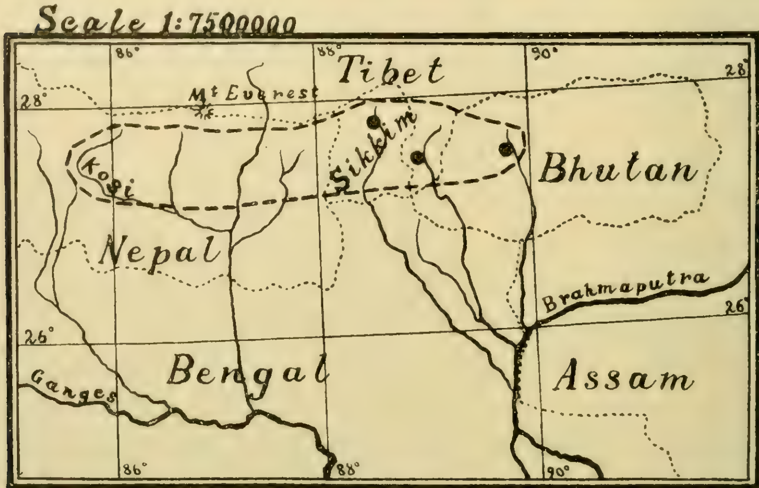
L. Griffithii, I. D. Hooker & Thomson in Cathcart, Ill.. Himal. Pl. 1855, t. 21. — Henkel & Hochstetter: Syn. Nadelh. 1865,

p. 136. — REGEL, in Gartenfl. XX, 1871, p. 106. — Id. in Act. Hort. Petrop. I, 1871, p. 161. — K. KOCH: Dendrol. 1873, p. 264. — I. D. HOOKER: Fl. Brit. Ind. V, 1890, p. 655. — SARGENT: Silva N. Am. XII, 1898, p. 4, Note. — MASTERS, in Journ. Linn. Soc. XXVI, 1902 p. 558. — ELWES & HENRY: Trees. Gr. Brit. and Irel. II, 1907. p. 388. — Bot. Mag. 4' Ser. IV, 1908, t. 8181. — BEISSNER: Nadelholzk. 1909, p. 305. — PATSCHKE in Engl. Bot. Jahrb. XLVIII. 1913, p. 651 (p. p). — REHDER & WILSON: 1914, in Sargent: Pl. Wilson. II. p. 20. — DALLIMORE & JACKSON: Handb. Conif. 1913, p. 286. —

Pinus Griffithii, PARLATORE, in De Candolle: Prodr. XVI, 2', 1868, p. 411. —

The English physician and traveller, WILLIAM GRIFFITH, discovered this larch in 1838 in Bhutan, near the village of Woolakoo, a little S. W. of Punakha in the Himalayas; this has subsequently been shown to be one of the most easterly localities within the inconsiderable zone of distribution, which extends from this spot in a westerly direction, and is assumed to reach about as far as the source of the Kosi river. The whole extent of the area within the bounds of which it is known is hardly 500 km. at its greatest length (from east to west) and 100—150 km. broad from north to south, and the only specimens seen by us are derived from the easterly section, that is to say, from the most westerly portion of Bhutan, extending a short distance into Nepal, together with the interlying Sikkim, and the southern point of Tibet, which extends between Bhutan and Sikkim. More recent discoveries of this larch have been made in localities situated between the most westerly regions of Bhutan, where GRIFFITH found it, and the Nango Mountains, where it was found by I. D. HOOKER in 1848; the only foundation for the report that its zone of distribution extends to the source of the Kosi is the statements of the natives. The whole zone is situated within the Himalayas, where it was first found at a height of from 1800 m.

to 2900 m. above sea-level. Specimens were subsequently found in the Chumbi valley, in the extreme south of Tibet, at an altitude of 3000 m., and in Sikkim it is stated to grow at elevations ranging from 2400 to 3600 m. above sea-level. These facts show it to be indigenous to the



Map I.

Larix Griffithiana (L. & G.) Carr.

highest tree-clad regions of the eastern Himalayas in the neighbourhood of the forest line, and only in the heart of vallies leading from north and south to the mighty peaks, the final and only mantle of which is the eternal snow. Hooker found it growing over ancient moraines at a height of 3600 m. above sea-level, where it attained its best development. He also found it upon grass-clad or thicket-strewn mountain slopes, but only where the soil was stony and the drainage good. It is thus shown to be a pronounced mountain tree, choosing the fresh, light soil for its abode. It represents the most southerly species of the genus, lat. 27°—28° N. (Map. I).

L. Griffithiana was discovered in 1838, but it was not described in detail until its re-discovery by HOOKER in 1848, who thereupon introduced it into England. HOOKER found it only as a small tree, 6—18 m. in height, in the west of Nepal, and it never becomes a tall tree, even although a rather greater height, 19,5 m., has subsequently been reported for specimens in Sikkim, and those found in the Chumbi valley, one of the most recently discovered locali-ies, are possibly a trifle taller still. A tree cultivated at Coldrennick in Cornwall is quoted as being 23,5 m. high, and as such is taller than any noted in their natural haunts. (Gard. Chron. XLI. 1907, p. 130; DALLIMORE & JACKSON, 1923, p. 287).

According to I. D. HOOKER's drawing of a tree in its native habitat in Sikkim (Fig. 1), the crown is broader, the branches differently arranged, and the branchlets longer and more pendulous than in the case of *L. decidua*, and HOOKER also compares it with *L. decidua* var. *pendula* (Gard. Chron. XXV. 1886, p. 719). It differs from most of the other members of the genus Larix in possessing cones of great size, reported by HOOKER as being 5—7,5 cms. long (Fl. Brit. Ind. V. 1890, p. 655). REGEL (1871; fig. 2 in present paper; same fig. in BEISSNER, 1909) has an illustration of a cone nearly 9 cms. long, and three cones from the already-mentioned tree in Cornwall are between 10 and 11 cms. in length. It is probable that the cones from cultivated specimens have a tendency to become larger than they would be in nature, and when DALLIMORE & JACKSON (1923, p. 286) state the size as being 5—10 cms. long, these figures perhaps include specimens from both cultivated and wild individuals.

The bracts are longer than the cone-scales, the same being the case with *L. Mastersiana*, *L. Potanini*, *L. Lyallii*,

Fig. 1. *Larix Griffithiana* (Lindl. & Gord.) Carr. Habit of a tree, from a drawing by Sir Joseph Hooker (Gardener's Chronicle June 5, 1886).

and *L. occidentalis*, but the difference is greatest in the case of *L. Griffithiana*; similarly, the free tips of the bracts are reflexed in a manner peculiar to this species and to *L. Mastersiana* only, which latter, together with *L. Potanini*, may be said to resemble it most closely. The beautiful dark violet scales of the immature cone are also characteristic (Bot. Mag. t. 8181).

Fig. 2. *L. Griffithiana* (Lindl. & Gord.) Carr. Cone. From E. Regel, in Gartenflora 1871.

Material of *L. Griffithiana* collected by I. D. Hooker in Sikkim at an altitude of 2700—3300 m. above sea-level is to be found in the »Herb. Ind. Or. Hook. fil. & Thomson«, which gives the following further characteristics. The leaves are placed in bundles containing up to 50, 1,5—3 cms. in length, the under-side being distinctly keeled between the rows of stomata. The first-year's shoots are very slightly pilose, of a shiny reddish-brown colour, with perhaps a slight, glaucous tinge. The material has been collected shortly after leafing, the leaves having attained their full length, but a few $^3/_4$—1 cm. long male flowers still being present. Pollination has taken place, the pollen-sacs being empty. A female inflorescence has also passed the flowering stage. It is $3^1/_2$ cms. long, and the bracts are so strongly recurved as entirely to cover the remaining portion of the yong cone. It is strongly coloured, and was probably dark purple-red, when fresh.

Further original material, No. 4989 of »Herbarium of

the late East India Company« in »Herb. Bot. Haun«. is part of Griffith's private collection. It has been collected at a rather earlier stage than the preceding, but the female inflorescence in this case also has probably passed the flowering stage, and its length of 2 cms. is almost certainly rather greater than that of the immature female flower. The colour appears to have been the same as that in Hooker's material, and the specimens show the same long, strongly recurved bracts, which, presumably, are already found before the flowering stage has been reached. The one-year's shoots have the same colour and the same faint downy covering as in the case of the previously-mentioned specimens. There are only a few leaves attached, which resemble the preceding specimens; the main bulk of loose leaves does not belong to *L. Griffithiana* at all, but apparently to *Cedrus deodora*. The same is true in the case of some of the unattached female flowers. This confusion need not be attributed to Griffith himself, but to subsequent mistreatment of his material (Vide Bot. Mag. 1908).

It is not known with any certainty, whether this species has been introduced into Denmark, as there are no existing specimens of cones from trees grown in this country under the name of *L. Griffithiana*.

Herb. Mat. examined:

E. Himalaya: Bootan, Herb. Griffith No. 4989 (Type, Kew) (Hort. Bot. Haun.); Sikkim reg. temp. 8—12000 Feet, Herb. I. D. Hooker (Kew; Hort. Bot. Haun); Sikkim, J. S. Gamble 1880 (Kew); Sikkim, Sipukung, Rilu & Rhomoo, 1911, (Kew); Smith & Care, Jeune Valley, No. 2771, Fl. of Sikkim 1909 (Brit. Mus.); Smith & Care, Laching, No. 2600, Fl. of Sikkim, 1909, (Brit. Mus.); Lachen, (= Laching) Sikkim, 1885, J. D. Hooker (Brit. Mus.); Fl. of Chumbi Phari, leg. Dungboo, 1879 (Brit. Mus.). Also seen in U. S. Nat. Mus. and in Arn. Arb. from the same localities.

2. **Larix Mastersiana**, Rehder & Wilson, *1914*, in Sargent: Pl. Wilson, II, p. 19. —

Dallimore & Jackson: Handb. Conif. 1923, p. 292. — Rehder: Man. Trees and Shrubs, 1927, p. 51. —

In the west of China, two species of larch are to be found, *L. Potanini* and *L. Mastersiana*, of which the former is the commonest, the later having only a very limited area of distribution.

L. Mastersiana occurs only inside the zone of distribution of *L. Potanini:* all in all, it is only known from three localities, lying north and south in the mountains west of the Min river. In 1908—1910, when Wilson discovered it, it was quite common in this restricted area, and being greatly in demand on account of its valuable timber, has decreased rapidly, but the inaccessability of its habitat prevents its extermination for the present.

It is a small tree, only some 10—20 m. in height. Its branches of the 2nd order are pendulous, although not so strongly as in the case of *L. Potanini* or *L. Griffithiana*, which generally resemble one another in this particular. The one-year's shoots are smooth, or very slightly pilose; the bark has a fresh, yellowish-brown colour. The leaves are placed in bundles of up to forty in number on the dwarf shoots, and are 1,2—3,5 cms. in length, light green in colour, with two light bands of stomata on the under-side. They present no appreciable difference from those of *L. Potanini*, being distinctly keeled on the under-side in similarity with the latter, the keel being less distinct on the upper-side, and only really apparent at the base. The 3—4 cms. long cone is brown, the bracts, which are longer than the cone-scales, are red and recurved. The length is described as being from 3—4 cms., but a cone from an original specimen lying before us (Wilson No. 906) has nevertheless attained a length of 4,5 cms.

L. Mastersiana is the link between *L. Griffithiana* and *L. Potanini*. It differs from the former in the size of the cones, which in the case of *L. Mastersiana* are not more than about half as long as those of the Himalayan larch. The difference in length between the bracts and the cone-scales is also much more marked in the case of *L. Griffithiana* than of *L. Mastersiana*. The two species differ in point of habitus, the branches of the second order of *L. Griffithiana* being considerably more pendulous than is the case with *L. Mastersiana*.

Fig. 3. *L. Mastersiana* Rehd. & Wils. Cones from China Western Szechuan. (leg. E. H. Wilson 1908) (Nat. size, upper row dry, lower row wet, the same two cones).

Compared with *L. Potanini*, the difference is most pronounced with regard to the orange or reddish-brown bark on the one-year's shoots of the latter, together with the comparatively short, straight, bracts, and the purple-red colour of the cones; in comparison, the bright, yellowish-brown shoots, and the longer, strongly recurved bracts, and the red and brown cones of *L. Mastersiana*, are very distinctive.

Following upon his discovery of *L. Mastersiana* in 1908, Wilson sent seeds to the Arnold Arboretum, but the tree is not yet in culture in Denmark.

Herb. Mat. examined:

W. Szechuan No. 906, E. H. Wilson 1908, Type, in Arn. Arb.; also in U. S. Nat. Herb.; Brit. Mus.; Kew Herb.; Hort. Bot. Haun. —

3. **Larix Potanini**, A. Batalin, in Act. hort. Petrop. XIII, *1894*, p. 385. —

Masters, in Journ. Linn. Soc. Bot. XXVI, 1902, p. 558. — Gard. Chron. 3. Ser. XXXIX, 1906, p. 178 (cum icon.). — Elwes & Henry: Trees. Gr. Brit. and Irel. II, 1907, p. 391. — Beissner: Nadelholzk. 1909, p. 307, (cum icon.). — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651. — Rehder & Wilson, 1914, in Sargent: Pl. Wilson, II, p. 18. — Rehder, in Journ. Arnold Arb. IV, 1923, p. 121. — Dallimore & Jackson: Handb. Conif. 1923, p. 297. — Wilson in Journ. Arn. Arb. VII, 1926, p. 46, — Hsen-Hsu-Hu & Woon-Young-Chun: Icon. Plant. Sinicarum, 1927, Pl. 2 — Rehder: Man. Trees and Shrubs, 1927, p. 50. —.

Syn:

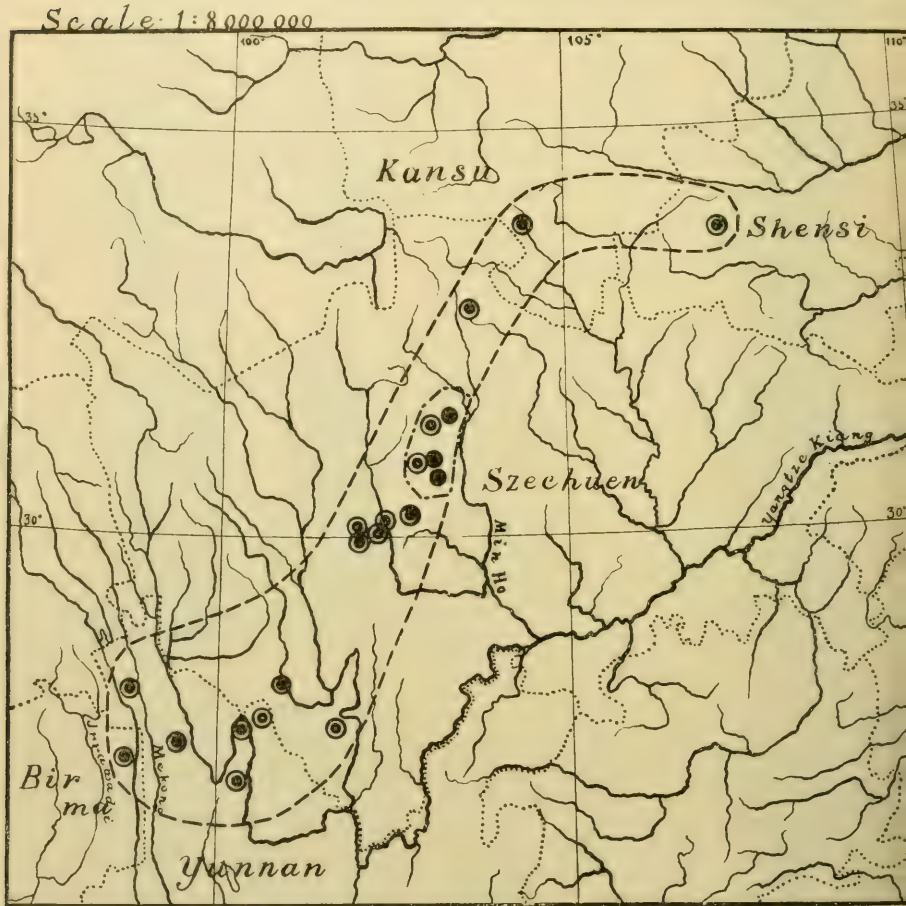
L. chinensis Beissner in Mittl. d. dendr. Gesellsch. 1896, p. 68. — Diels, in Engl. Botan. Jahrb. XXIX, 1901, p. 216. — Masters, in Journ. Linn. Soc. Bot. XXVI, 1902, p. 558. — Elwes & Henry: Trees. Gr. Brit. and Irel. II, 1907, p. 346. — Beissner: Nadelholzk. 1909, p. 303, (cum icon.). — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651. —

L. tibetica, Franchet, in Journ. de Bot. XIII, 1899, p. 262. — Diels, in Engl. Bot. Jahrb. XXIX, 1901, p. 216. — Masters, in Journ. Linn. Soc. Bot. XXVI, 1902, p. 559. —

L. Griffithii, Masters, in Journ. Linn. Soc. Bot. XXVI, 1902, p. 558. — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 746. — Non: Hook. f. & Thomson. —

L. Potanini occurs in a belt extending from the north-west of Yunnan, where it is broadest, northwards through Szechuan to a short distance into the interior of Kansu. Thence it follows the great mountain chain of Tsinling-shan eastwards to the extreme south-west corner of Shensi. The majority of finds has been made in Szechuan and in the north-west of Yunnan, where, generally speaking, it is common, and is a valuable forest tree. It is to be found there from an altitude of 2500 m. above sea-level and higher, until it finally disappears at the forest-line. Wilson

(No. 903) found it in 1908 north-east of Ta-tsien-lu at an altitude of 3300—4800 m. above sea-level, and no higher-lying locality has as yet been reported.



Map. II.

◉ ---- *Larix Potanini*, Batalin

• ------ " *Mastersiana*, Rehd. & Wils.

The first material was discovered by Armand David at Shensi, and was described by Franchet in 1884 as

Larix spec. POTANIN found the material for BATALIN's type in the neighbourhood af Ta-tsien-lu in 1893, and the majority of the subsequent finds originate from this locality. Specimens were found by PURDOM in 1910—1911 in Kansu and Shensi, and by ROCK in 1922 and 1924 as far south as the mountains around Yangtsze in the north-west of Yunnan (Journ. Arnold Arb. VII. 1926, p. 46). Several other finds had already been made in the north-west of Yunnan by HANDEL-MAZZETTI in 1914—18, but they were first reported in 1929 (HANDEL-MAZZETTI; Symbolae Sinicae, VII, 1, 1929). HANDEL-MAZZETTI also reports its occurrence from the south of Szechuan, and as far west as the mountains between Salween and the Irrawady in the extreme north-east of Burma. It is found in the greatest abundance, forming forests, at an altitude of about 3000 and 3400 m. above sea-level, and in scattered groups down to 2700 m. above sea-level.

The material for BEISSNER's *L. chinensis* was found in 1893—94 by Father GIUSEPPE GIRALDI at Tai-pei-shan in Shensi, and PURDOM's discovery originates from the same locality. This, together with the fact that the original material of *L. Potanini* agrees with BEISSNER's illustration (Fig. 70 in Nadelholzk. 1909), proves that the two species are identical. FRANCHET's *L. tibetica*, which was found by Prince Henry d'Orleans near Ta-tsien-lu, where so many finds of *L. Potanini* have subsequently been made, also coincides in every respect with the latter.

The length of the cone varies from 2,5—7,5 cms. Two cones from the already-mentioned highest known locality, north-east of Ta-tsien-lu, 3300 to 4800 m. above sea-level (WILSON No. 903) measure 2,5—3 cms. Two other cones from WILSON's material collected from about the same district.

west and south-west of Ta-tsien-lu, from 3300—4000 m. above sea-level, are 3,5—3,7 cms. long. William Purdom's No. 760 from the south of Kansu, 3000—3300 m. above sea-level, should be mentioned as representing material from a northern locality; six cones from this collection vary from 3 to 3,5 cms. in length. Rehder & Wilson estimate the average length of the cones taken from the intermediate and most northern localities to be 3—4,5 cms. (Pl. Wils. 1916, p. 19), but specimens from more southerly regions show that it can be considerably greater. Among George Forrest's material from the Likiang Range in the extreme north of Yunnan (George Forrest: No. 6745, 1910, lat. 27° 35′ N.), there are cones up to 5 cms. in length (Kew Herb.), and Rock's specimens from the same neighbourhood (1922—24) are, according to Rehder, 6—7 cms. long (Journn. Arnold Arb. VII, 1926, p. 46. See also f. *australis* Henry apud Handel-Mazzetti, 1929, l. c.). In this connection it should be stated, that Franchet had already described this species from Yunnan, and this accounts for his quoting a length as great as 5 cms. for ordinary cones (R. P. Delaway). The large cones, which demonstrably exist, give it a point of similarity with *L. Griffithiana*, and explain the reason for Masters and Patschke attributing this species to Szechuan on the

Fig. 4. *L. Potanini* Batal. Cones from China, Northern part. (W. Purdom No. 760). (Nat. size, upper row dry, lower row wet, the same two cones).

basis of PRATT's discovery (Journ. Linn. Soc. Bot. XXVI. 1902, p. 558; Engl. Bot. Jahrb. XLVIII, 1913 p. 746). FRANCHET, however (Journ. de Bot. XIII, 1899, p. 262), correctly identified PRATT's discovery with *L. tibetica* (= *L. Potanini* Bat.).

The distinguishing characteristics of *L. Potanini* from *L. Griffithiana* and *L. Mastersiana* are best demonstrated by an examination of the cones. In the case of the former, the bracts of the mature cone are not more than 2 mms. longer than the cone-scales, and are straight, while, in the case of the other two latter species, they are relatively longer, and strongly reflexed. The cone is violet with red bracts, that of *L. Mastersiana* being brown with red bracts.

The first-year's shoots are of a deep reddish-brown colour (WILSON, No. 903), or orange-brown (WILSON, No. 910), with prominent, lighter-coloured stigmata. The leaves are placed in bundles of up to fifty on the dwarf branchlets, 1,5—3 cms. in length, and are similar to *L. Mastersiana* in being distinctly keeled on the under-side, the keel on the upper-side being only noticeable at the base.

All three south-asiatic larches (*L. Griffithiana, L. Mastersiana* and *L. Potanini*) have a prominent keel on the underside of the leaf, and are also partly keeled on the upperside; but none of them can be compared to *L. Lyallii*, the leaves of which are prominently keeled on both sides.

The leaves of *L. Potanini* have been described as four-sided when seen in tranverse section, being keeled on the upper as well as the under-side (DALLIMORE & JACKSON: Handb. Conif. 1923, p. 297); but we have been unable to observe this dissimilarity from *L. Mastersiana* and *L. Griffithiana* in the specimens we have examined.

In the localities where the tree attains its best growth,

it reaches a height of 25—30 m., according to Rehder & Wilson, but A. E. Pratt observed specimens west of Tatsien-lu as high as 40 m. (Engl. Bot. Jahrb. XLVIII, 1913, p. 746). The crown is more slender in shape than that of *L. Griffithiana*, the branches of the first order being described as rather short. Branches of the second order are, on the contrary, pendulous in both species.

Single individuals of the species attain their best growth in the fertile, lower-lying, forest districts, but it only occurs scattered among other conifers and deciduous-leaved trees, and is more specially found along the sides of watercourses. It becomes more and more common as the ground rises, and in the highest-lying districts whole forests are composed of it.

It was introduced into Germany in 1899 under the name of *L. chinensis*. Seeds of it were sent to Beissner, and plants were successfully raised (Beissner: Nadelholzk. 1909, p. 305; vide Elwes & Henry: Trees Gr. Brit. and Irel. II, 1907, pp. 346—347). It was subsequently introduced into England, when Wilson in 1904 sent seeds from Szechuan to Veitch's Nursery Gardens. It is not found under cultivation in Denmark.

Herb. Mat. examined:

W. Szechuan, No. 910, E. H. Wilson 1908 (Arn. Arb.; U. S. Nat. Mus.; Kew.; Brit. Mus.; Hort. Bot. Haun.). — Lichiang Range lat. 27° 35′, 1910, Forrest No. 6745 (Brit. Mus.; Kew). — W. China, Hung-Sha, No. 3009, E. H. Wilson, 1904 (Brit. Mus.; Kew). — N. China, No. 760, Arn. Arb. Exp. Wm. Purdom (Kew; Brit. Mus.; U. S. Nat. Mus.; Arn. Arb.; Hort. Bot. Haun.). — Cam. Schneider, Iter chinense 1914, Szechuan austr., Kapala-Linku, 3800—4000 m. (Kew). — Kansu, T'ao River basin, 10—11000 ft. I. F. Rock, 1925, No. 12803. — Shensi sept., monte Kuon-tan-san 1894, ded. Beissner (Part of Type collection of *L. chinensis;* Kew). —

4. **L. occidentalis,** Nuttall: North Am. Silv. III, *1849*, p. 143, t. 120. —

SARGENT: Silv. N. Am. XII, 1898, . 11, t. DXCIV. — REHDER: Man. Trees and Shrubs, 1927, p. 51. —

Syn:

Pinus Nuttallii, PARLATORE in De Candolle, Prodr. XVI, 2. part, 1868, p. 412.

L. occidentalis together with *L. Lyallii* are representatives in North America of the type of larch characterised by possessing cones, the bracts of which are longer than the cone-scales, even when the cones attain maturity. Both species are indigenous to the most westerly parts of North America, where they are vicarious, *L. occidentalis* being a native of the mountains at an altitude of between 600 and 2100 meters, while *L. Lyallii* is an alpine tree, holding itself to the neighbourhood of the forest line between 1200 and 2400 m. above sea-level.

L. occidentalis is a valuable tree, which can attain very considerable dimensions under suitable conditions, namely, on fertile, deep soil in vallies. It occurs in Western Canada (British Columbia), and reaches its highest pitch of development in a section of the most north-easterly part of the State of Washington, the extreme west of Montana, and the northern parts of Idaho, where whole forests of it are often to be met with; while it is often found growing among *Thuja plicata*, *Pseudotsuga mucronata*, *Tsuga Albertiana*, *Picea Engelmanii*, and *Abies grandis*. In the most suitable localities, it can attain a height of 50—80 m. (SARGENT: Silv. N. Am. XII, 1898, p. 11; REHDER, 1927, p. 51), but as a rule it is less than 50 m. high. The girth may also be considerable, and trunks are mentioned having a diameter of up to 2 m. (HENRY & ELWES: 1907, p. 394), and about 2,5 m. (SARGENT: 1898, p. 11). Such girths are, of course, considerable, but not so enormous in relation

to the great height, and *L. occidentalis* in its habitat also grows slender, regular trunks with short lateral branches, and slender, pyramid-shaped crowns.

In April 1826, David Douglas made a journey up the Columbia River, and in the district lying in the fork made by the junction of the River Spokon and the Columbia, on his way to Fort Colville, he entered the great, fertile pine-forests, where *L. occidentalis* attains its greatest development. He did not differentiate it from *L. decidua*, which is later described, but he admired its imposing dimensions and the excellence of its timber, writing in his journal: »I measured some thirty feet in circumference; and several which had been levelled to the ground by the late storms, were one hundred and forty-five feet long, with wood perfectly clean and strong«, and he also states that they were the commonest conifers met with in the district (Companion to the Bot. Mag. II, 1836, p. 109). The tree is a splendid one, surpassing all the other species of larch in height and girth where it attains its best development, and possesses a shape and timber as valuable as the best of the other species.

Its area of distribution lies like a ring around the lowland, formed by the central part of Washington and the northern of the Oregon up to the northern side of the Blue Mountains. This is the Great Plain of the Columbia River. It is most extensively distributed towards the north-east in the Rocky Mountains; the line then takes a north-westerly direction towards the Cascade Mountains, which it follows southwards until a little south of the Columbia River, where it bends eastwards and continues — in somewhat straggling groups, it must be confessed — until it again reaches the Rockies.

Map. III.

● ---- *Larix occidentalis, Nutt.*

● -·-·-·- *Larix Lyallii, Parl.*

Its cone is 2,5—3,5 cms. in length, and the open form with the long, visible bracts, which are straight or only slightly recurved, make it easily recognisable. The scales

Fig. 5. *L. occidentalis* Nutt. Branch and cone from Montana, Glacier National Park, Lake Mac Donald, ca. 1000 m (leg. I. G. Jack, Sept. 1921). (Nat. size, left wet, right dry, the same branch).

are thin, and their free tips are straight, or slightly recurved. The basal portion of the outer side is finely pilose. The female inflorescence are deep red with green mid-rib and mucro (U. S. Nat. Herb.), and the male flowers are rather long. The young shoots are brown and pilose, becoming smooth at a later period, the leaves 2,5—4,5 cms. long; they are green, and not blueish-green. Vigorous

shoots of young trees are provided with particularly long leaves, giving them the characteristic appearance, which by itself alone renders them distinguishable from the other

Fig. 6. *L. occidentalis* Nutt. Cones from cultivated trees. Botanical Gardens, Copenhagen 1928. (Nat. size, upper row dry, lower row wet, the same two cones).

cultivated species. It was introduced into Europe (Kew) in 1881, and thrives well under cultivation in Great Britain, developing the same fine form of growth as when found in its native surroundings, but is attacked by *Dasyscypha Willkommi*, with which it has also been badly beset in Denmark (Hæsede Nursery at Gisselfeld, Dr. Børgesen's garden in Hellebæk, the Nurseries of the Danish Experi-

mental Forestry Service at Egelund; vide A. Oppermann: Cultivation of the Larch in Denmark in Det forstlige Forsøgsvæsen i Danmark, VII, p. 276). In forests and gardens its occurrence is as yet rare.

Herb. Mat. examined:

Brit. Columbia.: Deer Park, Lower Arrow Lake, 1890, Macoun (Gray Herb.). — Upper Arrow Lakes, 1889, Dawson (Ottawa Herb.). — Between Lower and Upper Arrow Lakes, 1890, Macoun (Ottawa Herb.) — Sicamous, 1889, Macoun (Ottawa Herb.). — Colombia Slope, 1834, Herb. Nuttall, Type collection (Brit. Mus.). — Columbia River from lat. 48°—49° N., several specimens, Dr. Lyall, 1860 (Kew; Gray Herb.), — Columbia River 1890, John Macoun, (Brit. Mus.). — Selkirk Flora, 1905. Chas H. Shaw, a) Wood W. of Nelson, b) Hills near Howser Lake (Brit. Mus.; U. S. Nat. Herb.; Gray Herb.). — Washington: Blue Mts. Columbia Co. 1897 (Gray Herb.). — Swank River, 750—1800 m., Sharples, 1913, (Gray Herb.). — Near Kettle Falls and in the Rocky Mountains, 1826, David Douglas (Kew). — Cascade Mts., T. S. Brandegee, 1882, Ex Herb. Univ. Calif. (Hort. Bot. Haun.). — Suksdorf, Fl. of Washington, Mt. Paddo, Adams 1883 (Brit. Mus.; Gray Herb.). — Oregon: Union, Col. Casick 1882 (Kew). — Petty's Canon, 1880, S. Watson (Gray Herb.). — Big Fork, 1908, J. Clements (Gray Herb.). — Clear water (Gray Herb.). — Near Mt. Hood, Walpole, 1898 (U. S. Nat. Herb.). — Montana: Columbia Falls, 1893, Williams (U. S. Nat. Herb.). — Lower valley of Clarks Fork, 650 m. J. B. Leiberg, 1895 (Gray Herb.; U. S. Nat. Herb.). — Fl. of Idaho, Craig Mts. near Lake Waka, 1892 (Brit. Mus.; Gray Herb.). — Fl. of Idaho, Payette Lake, 1899. Marcus Gray Jones (Brit. Mus.). —

5. **L. Lyallii**, Parlatore, in Enum. Sem. Hort. Reg. Mus. Flor. *1863*.

Journ. Bot. I, 1863, B. 35, and, in Gard. Chron. 1863, p. 916. — Sargent: Silv. N. Am. XII, p. 15, t. DXCV. — Rehder: Man. Trees and Shrubs, 1927, p. 51.

Syn:

Pinus Lyallii, Parlatore in De Candolle Prodr. XVI. 2. 1868, p. 412.

L. Lyallii, has for its area of distribution two regions divided from one another, one towards the east in the Rockies, and one to the west in the Cascade Mountains.

Within both areas, it goes southwards to about lat. 45° N., that is to say, as regards the western area, a trifle south of the Columbia River, and north again to about the

Fig. 7. Group of *L. Lyallii*, forming forest line above Lake Louise, Alberta, Canada. Ca. 2000 m. (Aug. 1924. C. H. Ostf. phot.).

boundary line between Washington and British Columbia; in the eastern area, it follows the boundary between British Columbia and Alberta northwards to the neighbourhood of Mount Hooker. On the west, it runs a little nearer to the coast than, and on the north-east, a little beyond the

limits of, *L. occidentalis.* This area of distribution corresponds with the more alpine character of *L. Lyallii*, which is therefore found at higher altitudes than the latter on the great mountain chains bounding their mutual domains. (See Maps III & VIII).

L. Lyallii, in contrast to *L. occidentalis*, is of very small importance as a forest tree. Under favourable conditions, it succeeds in reaching a height of 20—25 m., but is frequently lower. It grows but slowly in the harsh climate of the upper forest-line, where it has its home; Brandegee counted as many as 562 annual rings in a trunk about 50 cms. in diameter.

From the taxonomic point of view, *L. Lyallii* and *L. occidentalis* resemble one another closely, and it is also probable that their characteristics can vary to such an extent, that they overlap. Even so, they are, nevertheless, so dissimilar, that they must be regarded as two different species.

The cone is larger than that of *L. occidentalis* (3,5—5 cms. in length), but has the same open form, and the long, visible bracts which characterise the latter. The scales are more pilose, and become a little more recurved at maturity. The cone at the flowering-stage has dark red, rarely green, scales, while the bracts are of more pronounced red shade. The long mucro of the bract is also deep red, in contrast with *L. occidentalis* (U. S. Nat. Mus.). The male flower is long, the young shoots are strongly pilose, the hairs light brown; the leaves are 2,5—4 cms. in length, and blueish-green; the transverse section shows them to be rhomboid, and considerably thicker than those of *L. occidentalis.* The leaves, which may be as long as those of *L. occidentalis*, are more quadrangular than those af any other species, which fact, together with the densely pilose young shoots,

makes *L. Lyallii* easily recognisable, even without the cones. The wings of the seeds are stated to be of a faint red colour in contradistinction to those of *L. occidentalis*,

Fig. 8. *L. Lyallii* Parl. One year's shoot showing dense pilosity. Montana, Glacier National Park, Piegan Purs, 2100 m. No. 2204 (leg. J. G. Jack, Sept. 1921).

Fig. 9. *L. Lyallii* Parl. Cone from British Columbia, Tecamores (leg. John Macoun, July 1889). (Nat. size, upper dry, lower wet)

where they are brown; but the material of *L. Lyallii* from Glacier National Park (2100 m. above sea-level) in Montana, and from Tecamores in British Columbia, presents this difference to a slight degree only, and it can, no doubt, be entirely absent.

In recent times (1893 and later), trials have been made

in England with the cultivation of *L. Lyallii*, but it thrives very poorly; the attempts have only resulted in raising a few isolated specimens, which, however, only grew for a short time. In Denmarks no attempts at cultivation have been made.

Herb. Mat. examined:

Alberta: Silver City 1885, JOHN MACOUN (Brit. Mus.). — Near Banff, W. C. CALLA, 1899 (Kew). — Selkirk Mt. 1904, Summit of Burgess Trail, H. PETERSEN (Brit. Mus.; Gray Herb.). — Lake Louise, 1905, EDITH M. FARR (Brit. Mus.; Gray Herb.). — Above Lake Louise, 1924, C. H. OSTENFELD (Hort. Bot. Haun.). — Lake Agnes & Mt. Piron, FRANCES C. PRINCES 1900 (Gray Herb.). — Lake Agnes, 6800 ft., C. S. SARGENT, 1897 (Gray Herb.; U. S. Nat. Herb.). — Near Lake Agnes, 7400 ft., MACOUN, 1904 (Ottawa Herb.). — Pipestone Valley S. of Summit, Headwaters of the Saskatchewan and Athabasca River, STEWART & BROWN, 1908 (Gray Herb.). — Sheep Mt., MACOUN, 1895 (Ottawa Herb.). — Brit. Columbia, Tecamores, JOHN MACOUN, 1889, Ex. Herb. Geol. & Nat. Hist. Surv. Canada (Hort. Bot. Haun.). — Kicking Horse Lake, JOHN MACOUN, 1890 (Brit. Mus.). — Kootanie Pass., DAWSON AUG. 1881, and MACOUN 1890 (Ottawa Herb.). Kootanie Valley, DAWSON July (Gray Herb.). — Kanashir Summit, R. M., 7000 ft. DAWSON, July, 1884 (Ottawa Herb.). — Washington: Cascade Mt. to Fort Colville, Dr. LYALL, 1860 Type collection (Kew, also in Gray Herb.). — Fort Colville to Rocky Mountains, Galton Range, Dr. LYALL 1861, (Kew). — Near Mt. Stewart, T. S. BRANDEGEE, 1883, Ex. Herb. Univ. Calif.; (Hort. Bot. Haun.; Kew; Brit. Mus.; Gray Herb.), — Yokima Region, 6200 ft. 1883. — Forest Reserve, 5700—5800 ft., 1897. Mt. Stuart, 1898; Wanalschee Mt. 1901 (U. S. Nat. Herb.). — Fl. of Montana, MARCUS E. JONES: a) Hamilton, Bitter Root Valley 1905 (U. S. Nat. Herb.); b) Darby 1909 (Brit. Mus.). — Glacier Nat. Park, 2100 m., Arn. Arb. Journey to Montana, No. 2204 (Hort. Bot. Haun.). — Horse Pass, Montana, 200 m. (U. S. Nat. Herb.). —

6. **Larix Kaempferi,** (LAMBERT, *1824*), SARGENT: Silv. N. Am. XII, *1898*, p. 2. Note.

WILSON: Conif. and Tax. Jap. 1916, p. 30. — REHDER: Man. Trees and Shrubs, 1927. p. 51. —

Syn:

Larix conifera nucleis pyramidatis, foliis deciduis, Engelbertus, Kaempferus: Amoenitarum exoticarum, 1712, p. 883. —

Pinus Larix, CAROLUS PETRUS THUNBERG: Flora Japonica, 1784, p. 275. — Non L. 1753. —

Pinus Kaempferi, LAMBERT: Genus Pinus, II, 1824, p. V. —

Abies leptolepis, SIEBOLD & ZUCCARINI: Fl. Jap. II, 1842, p. 12, t. 105. —

Larix japonica, CARRIÈRE: Traît. Conif. 1855, p. 272. — Non MURRAY, 1863. —

L. leptolepis, GORDON: Pinetum, 1858, p. 128. — MURRAY: Pines and Firs, Jap. 1863, p. 89. — BEISSNER: Nadelholzk, 1909, p. 307. — O. G. PETERSEN: Forstb. 1920, p. 247. — A. OPPERMANN, in Det forstl. Forsøgsv. i Danmark, VII, 1923, p. 266. — DALLIMORE & JACKSON: Handb. Conif. 1923, p. 288. —

The Japanese Larch is only found in the wild state in the interior of Hondo at about the same latitude as Tokio, while it is cultivated in the north and south, and also upon the large islands of Hokkaido, Schikoku, and Kiuschiu. Its area of distribution runs roughly east and west across Hondo from the province of Kaga in the west, through Shinano to the district around Nikko in the province of Shimotsuke, where it reaches its most easterly and most northerly point of occurrence. The area forms a belt 80—100 km. wide, and 250—300 km. long (see Map V). It is common within these limits, and grows at an altitude of between 500 and 2300 m. above sea-level, keeping to the volcanic soil. On Fuji-Yama it occurs right up to an altitude of 2900 m., but, at the extreme limit, only as a stunted bush hardly 1 m. high (MURRAY: 1863, p. 97). I. G. VEITCH was the first to draw attention to this form, which MURRAY in 1863 described as a separate species, *L. japonica* (non Carrière). After its subsequent introduction to the Arnold Arboretum in 1892, it has been demonstrated that it does not retain its dwarf growth, and does not deviate from the species in any important characteristic.

WILSON has given a detailed description of its occurrence

upon the basis of his own observations (Wilson: 1916, pp. 30—31), and he states that is has a tendency to form pure growths of considerable extent, otherwise occurring only in company with other conifers such as *Pinus densiflora*, *Abies homolepis*, *A. Veitchii*, *Picea jezoensis*, *Tsuga diversifolia*, and deciduous foliage trees, such as oak, birch, hornbeam and beech. Sirasawa, however, states that it most frequently occurs in mixed forests (Sirasawa: 1910, p. 307). As a rule, it attains a height of 25—26 m. with a girth of 2—3 m.; but it can, under exceptional circumstances, reach 33 m. with a girth of 4 m. In speaking of its occurrence upon Fuji-Yama, Wilson remarks, that *Pinus pumila* as a rule is not found here, and consequently the light-loving *L. Kaempferi* is allowed to dominate in these greater altitudes, where otherwise *Pinus pumila* is the only ruling tree or shrub.

The recurved cone-scales, which are generally very distinctive, make *L. Kaempferi* an easily recognisable larch. It varies in size, and large cones are common in cultivated specimens. Mayr, who may be supposed to have been intimately acquainted with the species in its native country, states that the cones only attain a length of 1,5—3 cms. in their natural habitat, becoming as long as 3,5 cms. under cultivation (Mayr: 1890, p. 65). He mentions the illustrations in Siebold & Zuccharini: Fl. Jap. II, 1842 (Plate 105), which reproduce two cones 3,5 cms. in length, as an example of a cultivated specimen with large cones. Under culture in Denmark, this tree has produced cones as long as 4 cms. (Strødam near Hillerød, and Tinning Forest near Friijsenborg).

The female cone in the flowering stage is violet; the bracts have a green mid-rib; the species seems to vary

very little. Pale flowers are not mentioned, and flowers only a trifle lighter in shade are found in cultivated spec-

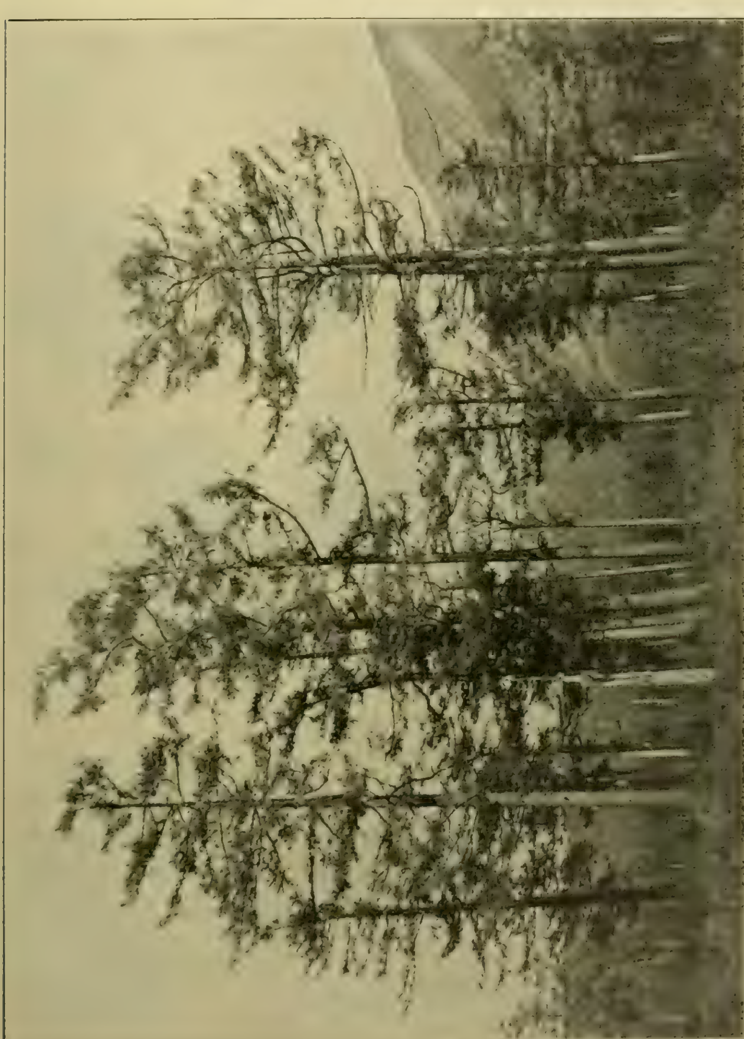


Fig. 10. *Larix Kaempferi* (Lamb.) Sargent. (From E. H. Wilson, Conifers and Taxads of Japan, 1916).

imens (Egelund Nurseries under the Danish Experimental Forestry Service). The first-year's shoots are stout, yellow

to reddish-brown, most frequently a fresh chestnut-brown, and may be smooth or pilose. The leaves are 3—3,5 cms. long, blueish green in colour, with stomata on both sides, and have a prominent keel on the under-side.

Wilson describes the crown as narrow and somewhat pyramidal, the branches numerous, thin, and short. Usually

Fig. 11. *L. Kaempferi* (Lamb.) Sarg. Cones from cultivated trees. Denmark, the Garden of Forest Botany, Charlottenlund, 1922 ($^3/_4$ nat. size, upper row dry, lower row wet).

they project horizontally from the trunk, but are sometimes bent upwards or downwards; this description is confirmed by an illustration of a group of older trees (Wilson: 1916, Plate XV). (Fig 10). Under culture in Europe, *L. Kaempferi* seems to have a tendency towards developing a broader crown with stouter, longer branches, than those of *L. decidua*, but as there are at present only young trees up to 60 years of age in culture, there is some hope that, as time goes on, they will adopt a — from the forestry point of view — more satisfactory form, and one more in keeping

with WILSON's description of them from their home. Although the Japanese Larch was mentioned by KAEMPFER already in 1712, it was first described by LAMBERT in 1824, and first introduced into Europe in 1861, when JOHN GOULD VEITCH sent seeds to the Nursery Gardens near London. It came to Denmark in 1889 (The Garden of Forest Botany at Charlottenlund), and is now, thanks to its vigorous early growth, and stout, picturesque appearance, a tree in common use in forests and gardens.

Herb. Mat. examined:

Yokohama, 1862, MAXIMOWICZ (Brit. Mus.). — Chinsenji, Nikko, BINET, 1877 (Brit. Mus.). — Nippon, Jizogatake 1903, FAURIE, No. 5344 (Brit. Mus.). — Nippon, Asamayana, 1904, FAURIE (Brit. Mus.). — Aomori, culta, 1905, FAURIE (Brit. Mus.). — Also seen in Kew etc. — Numerous cultivated specimens from Denmark, etc.

7. **Larix Gmelini** (RUPRECHT *1845*), GORDON: Pinetum *1858*, p. 123. —

Herb. Fl. Ross., Mus. Bot. Acad. Imp. Petropol. edit. 1912. — Conf. MIDDENDORFF in Middf. Reise, IV, 1. 1867 p. 527, Note. —

Syn:

Abies Gmelini, RUPRECHT, in Beitr. Pflanz. Russ. Reich. 2. Lief. 1845, p. 56. —

Abies kamtschatica, RUPRECHT 1845, l. c. p. 57. —

Pinus dahurica, FISCHER, in Schtschagl. Anz. f. Entd. in d. Phys. Chem. Natur. u. Techn. VIII, 3'. 1831 (nomen nudum). — TURCZANINOW, in Bull. de la Soc. Imp. Natur. de Mosc. XI, 1838, p. 101 (nomen nudum). — Id., Fl. Baical. Dahur. I. 1842—45. p. 14, (nomen nudum). — ENDLICHER: Syn: Conif. 1847, p. 128. — LEDEBOUR: Fl. Ross. III, 1846—51. — TRAUTVETTER in Act. Hort. Petrop. V, 1877, p. 111.

Pinus Kamtschatica, ENDLICHER: Syn: Conif. 1847, p. 135. (Species inquirenda). — LEDEBOUR: Fl. Ross. III, 1846—51, p. 673. —

Larix dahurica, TRAUTVETTER: Pl. Imag. Descrip. Fl. Russ. III. Fasc. 7, 1846. p. 48, Tab. 32. — TURCZANINOW, in Bull. de la Soc. Imp. des Natur. de Mosc. 1838, p. 101 (nomen nudum). — TRAUT-

vetter in Middf. Reise, I, II, 4', 1847, p. 148. — Carrière: Trait. Conif. 1855, p. 270. — Trautvetter & Meyer in Middf. Reise, I, II', 2', 1856, p. 88. — Maxim.: Prim. Fl. Amur. 1859, p. 262. — Radde, in Baer & Helmersen: Beitr. Kennt. Russ. Reich. XXIII, 1861, p. 608, — Henkel & Hochstetter: Syn: Nadelh. 1865, p. 138. — Middendorff, in Middf. Reise, V, 1', 1867, p. 527. — Fr. Schmidt, in Mém. Acad. Imp. Sci. St. Petersbourg, Sér. 7, XII, No. 2. 1868, p. 63. — Regel, in Gartenfl. XX, 1871, p. 104, et in Act. Hort. Petrop. I. 1871, p. 159. — K. Koch: Dendrol. 1873, p. 261. — Masters, in Journ. Linn. Soc. Bot. XVIII, 1880, p. 522. — Willkomm: Forst. Fl. 1887, P. 155. — Herder, in Act. Hort. Petrop. XII, 1892, p. 98. — Sargent: Silv. N. Am. XII, 1898, p. 4. Note. — Cajander, in Act. Soc. Sci. Fennicæ, XXXII, No. 3. 1904, p. 8. — Mayr: Fremdl. Wald- und Parkb. 1906, p. 299. — Elwes & Henry: Trees, Gr. Brit. and Ireland II, 1907, p. 379. — Beissner: Nadelholzk. 1906, p. 319. — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651. — A. Oppermann, in Det forstl. Forsøgsv. i Danmark VII, 1923, p. 271. — Okada, in Bot. Mag. Tokio XXXVIII, 1924. — Komarow, in Acad. Sci. Publ. Foederat. Soviet. Social. 1927, p. 101. — Hultén, in Kungl. Sv. Vetensk. Handl. Ser. 3, V. 1928, p. 68. —

Larix Kamtschatica, Carrière: Traît. Conif. 1855, p. 279. — Middendorff, in Middf. Reise, IV, 1. 1867, p. 529. — Elwes & Henry: Trees, Gr. Brit. and Irel. II, 1907, p. 343. —

L. sibirica, Maximowicz, apud Regel: Veget. Skitz. Amur. 1856, p. 495. — Id. in Bull. Acad. St. Petersbourg XV, 1857, p. 226. — Herder, in Act. Hort. Petrop. XII, 1892, p. 102 (p.p.). — Masters, in Bull. Herb. Boiss. VI, 1898, p. 272. — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651 (p.p.). — Non Ledebour. —

L. decidua var. rossica, Henkel & Hochstetter: Syn: Nadelh. 1865, p. 133, (p.p.). — Non Regel. —

L. dahurica var. japonica, Maxim., apud Regel, in Gartenfl. XX, 1871, p. 105, cum icon. — Miyabe, in Mem. Boston Soc. Nat. Hist. IV, 1890, p. 261. — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651. — Wilson: Conif. and Tax. Jap. 1916, p. 33. — Miyabe & Kudo: Icon. Ess. For. Hokkaido 1920, p. 23. — Rehder: Man. Trees and Shrubs, 1927. p. 52. —

L. intermedia, K. Koch: Dendrologie, 1873, p. 260 et 261 (pp.). —

L. kurilensis, Mayr: Monogr. Abiet. Jap. 1890, p. 66. Pl. V. — Elwes & Henry: Trees, Gr. Brit. and Irel. II. 1907, p. 383. — Beissner: Nadelholzk. 1906, p. 321. — Dall. & Jackson: Handb. Conif.

1923, p. 287. — A. OPPERMANN, in Det forstl. Forsøgsv. i Danmark VII, 1923, p. 275. —

L. dahurica var. kurilensis, SARGENT: Silv. N. Am. XII, 1898, p. 4, Note. —

L. Cajanderi, MAYR: Fremdl. Wald- und Parkb. 1906, p. 297. — ELWES & HENRY: Trees, Gr. Brit. and Irel. II, 1907, p. 346. — DALL. & JACKSON: Handb. Conif. 1923, p. 279. —

L. dahurica var. pubescens, PATSCHKE, in Engl. Bot. Jahrb. XLVIII, 1913, p. 651. —

L. dahurica var. kamtschatica, MIYABE & KUDO: Icon Ess. For. Hokkaido, 1920, p. 26. — KUDO, in Jap. Journ. Bot. II, 1925, p. 52 et 217. —

L. Gmelini (L. dahurica) is a very common tree throughout the entire forest-clad regions of Eastern Siberia, vast tracts being often entirely composed of it, especially in the north, where it alone forms the forest line (See Map V). Its most northerly point of occurrence is near the Chatanga and its tributary, the Novaja, at lat. 72°—72$^1/_2$° N. (Middf. Reise IV, 1867, pp. 595 and 604), and further eastwards, at the mouth of the Lena, it reaches nearly as far north as lat. 72° N. (CAJANDER in Act. Soc. Sci. Fennicae, XXXII, No. 3, 1904, p. 32). From these outposts in the extreme north, it extends southwards through the whole of Eastern Siberia, and reaches its most southerly point of occurrence at about the same latitude as Vladivostok, where it goes over to *var. olgensis,* which carries the area of occurrence further southwards. In the southern parts of the area of distribution, it goes westwards to Lake Baikal, the northerly part reaching as far west as the district around the mouth of the Jenisej. Near Lake Baikal, and along the banks of the Lena from Kirensk to Oleminsk, forms are found intermediate between the typical *L. Gmelini* and *L. sibirica;* the same phenomenon might also conceivably be observed

further north in a belt, where the two species meet one another (Cajander; ibid p. 8). Similar forms probably occur in the extreme north near the mouth of the Jenisej, contradictory reports existing regarding the larch species in these districts. Scheutz states that *L. sibirica* is the only larch near the Jenisej, also attributing the most northerly, stunted specimens between Dudino (Lat. 69° N.) and the Arctic Sea to this species (Kgl. Sv. Vet. Handl. XXII, No. 10, p. 41). Middendorff, who devoted special attention to the relation between the two larches, and endeavoured to fix the boundary between them during his sojourn near the Jenisej, came, on the other hand, to the result, that the dividing line between *L. Gmelini* and *L. sibirica* must be looked for between lat. 67½° and lat. 68½° N., and that only *L. Gmelini* at any rate was to be found at lat. 69½° N. He also suggested the possibility of the existence of a transition belt with intermediate forms between the two species (l. c. pp. 530 and 595). Middendorff supposed that *L. Gmelini* formed the forest line as far west as about the spot where the Ob empties itself into the Arctic Sea (l. c. p. 538). His statements here are not based on personal observation, and *L. Gmelini* has never subsequently been found so far west; Scheutz too (l. c. p. 47) only found *L. sibirica* there. The relation between the two species will be seen from the foregoing to be still insufficiently illuminated, but as already stated, it appears reasonable to suppose that a transitional zone lies in this district as well, and that in all probability the boundary lies somewhere in the neighbourhood of the mouth of the Jenisej.

Eastwards, *L. Gmelini* is found as far as the coast bordering the Sea of Ochot, the only localities where it does not occur being the coast of Kamtschatka and the northern

section of the gulf between Kamtschatka and the mainland. It extends further to the small islands along the coast, passes over to Sachalin and to the most southerly of the Kurile Islands, viz., Shikotan and Etorofu. On the north-east, it reaches its extreme limit near the Anadyr River, which, however, it only follows for a short distance south of lat. 65° N., never overstepping lat. 65° N. and long. 172° E. Finally to its area of distribution must be added the isolated occurrence in the interior of Kamtschatka.

The limit for its occurrence on the north-east towards the Sea of Ochot, as well as the northern boundary, is given on our map in accordance with MIDDENDORFF's detailed accounts (l. c. pp. 530—535). The occurrence in Kamtschatka is reproduced from the map of HULTÉN (Kgl. Sv. Vet. Handl. V, No. 1, p. 284), and KOMAROV (Acad. Sci. Phil. Foederat. Soviet Social., 1927, p. 101), and with regard to the localities on Sachalin and the southern Kurile Islands, several detailed notes exist, the most exhaustive of which has been supplied by MIDDENDORFF (1867), FR. SCHMIDT (1868), MAYR (1890), and MIYABE & KUDO (1920).

Within this extensive area of distribution, between lat. 43° N. and lat. 72½° N., and between long. 85° and 172° E., the species undergoes considerable variations in habit. It is found in every possible form, from low, stunted specimens in the most northerly localities, to shapely trees in the southern vallies 80 to 100 feet high. MIDDENDORFF, who has given the, hitherto, most detailed description of this species on the basis of his own observations, has supplied several sketches of types varying from the fine, single-trunked tree near the Aldan River at lat. 61½° N., to the century-and-a-half old stunted, zig-zag bent specimens from the River Novaja at lat. 72½° N. (Fig. 12).

A little to the south of the most northerly localities with the quite dwarf, stunted specimens, more or less open forest is found, becoming denser and better formed the further south it approaches. The growth everywhere in the northern localities is slow, and the average size small. Thus, the larch in the Arctic circle seldom exceeds 12 m. in height at the Lena, and the trees are all more or less stunted. The forest is so open, that the branches hardly touch one another, and rejuvenation is very slow. Cajander, who described the forest there also, examined a number of trees in the neighbourhood of Shigansk on the Lena, close to the Artic circle, and as the measurements give a good impression of the slowness of growth, they are given here: —

	Height	Girth	Age
I	190 cms.	—	about 85 years
II	295 —	26 cms.	90 —
III	310 —	—	95 —
IV	640 —	—	110 —
V	700 —	—	136 —
VI	710 —	—	130 —
VII	750 —	—	120 —
VIII	940 —	41 cms.	150 —
IX	990 —	—	160 —
X	1100 —	—	150 —

The following three younger trees, however, were measured at the same time and in the same locality:

	Height	Girth	Age
I	350 cms.	13 cms.	17 years
II	570 —	24 —	38 —
III	755 —	34 —	51 —

These three trees as well as those in the first table show that the rate of growth can vary considerably, even within the same area, but, taken as a whole, the figures indicate only a slow rate of growth, agreeing well with the descriptions (CAJANDER: 1904, l. c. p. 23).

MIDDENDORFF supplies information with regard to the appearance of the larch near the Aldan River and its tri-

Fig. 12. *L. Gmelini* (Rupr.) Gordon. very old, stunted specimen, from lat. $72^1/_2$ ° N., river Novaja. From Middendorff, Reise, 4. Vol. p. 605.

butary, the Milja, from about lat. 60° N. His illustration (Vol. IV, 1867, p. 538 reproduced here as Fig. 13) of a tree near the Aldan River, bears witness to good shape, and his measurements of trees on the Milja at lat. 60° N. (l. c. p. 539) indicate considerable size as well. One of the tallest trees found was 80 ft. high, the girth of the trunk $3^3/_4$ ft. above the level of the ground being 6 ft. 4 inch., and at a height of 56 ft., 2 ft. 4 inch.; from the district] around Jakutsk eastwards through the Stanowoj Range, the East-Siberian larch also develops into a valuable forest tree. The tallest trees mentioned by MIDDENDORFF were found on the west slope of the Stanowoj Range, and were 80—100 ft. high. In a more southerly direction, in the neighbourhood

Fig. 13. *L. Gmelini* (Rupr.) Gordon. Tall tree at the river Aldan, lat. $60^1/_2$° N. From Middendorff, Reise, vol. 4. p. 538 (Abt. 80 feet high).

of the Amur River and its tributaries, it probably attains an even greater height, both Fr. Schmidt and Maximowicz describing the occurrence of large, fine specimens with a diameter of up to 4 ft. (Maxim. 1859, pp. 393—394).

It appears to be an extremely common tree in all districts within its extensive area of distribution, and in the localities in the extreme north, it predominates over all other kinds of trees. Thus CAJANDER, on his journey down the Lena, noticed that the spruce disappeared a little to the north of Jakutsk, the fir being still found a few degrees further north, while the larch was supreme from about lat. 64° N. right up to the forest-line at the mouth of the Lena at lat. 72° N. (CAJANDER: 1904). A good impression of how dominating, nay, supreme, it becomes in comparison with other trees in wet, tundra-like districts, may be gained from OKADA's description of its occurrence on Sachalin (OKADA: 1914), where the larch is able to form whole forests on tracts that are so wet, that the undergrowth is composed, inter alia, of Ledum, Myrica, Vaccinium, Andromeda, and Oxycoccus. Finally, it is met with in the „high moor formation", although certainly only as small individuals (vide SCHMIDT, 1868, p. 14; BEISSNER, 1909, p. 320, and REGEL in Gartenfl. XX, 1871, p. 105).

We have seen that *L. Gmelini* reaches farther north and farther out on the flat, wet areas than other coniferous trees; it possesses also a marked propensity for withstanding the foggy, inclement climatic conditions prevailing in the regions abutting the Sea of Ochot, which it closely approaches on the Kurile Islands, as well as on Sachalin and the mainland, from about lat. 61° N.; further southwards, it goes out on the many small islands along the coast.

It not only contrives to exist under the inclement conditions, high winds and a cold, damp atmosphere, to which it is exposed, but can also develop into a tree of considerable dimensions. Thus WILSON gives its height on Sacha-

lin as being 20—30 m., while Mayr found it at its best on Etorofu in the Kurile Islands, and measured specimens as high as 22 m. with a girth up to 1 m. breast-high above the level of the ground; in the exposed localities on Shikotan it only occurred as small, stunted specimens, 10 ft. high. While its growth and outward form suffer under exposure, the influence of the damp atmosphere endows it with fine, luxuriant foliage, and the transition between the normal, well-developed larch forest, and the stunted, wind-swept, but luxuriantly green shrub of the coast localities, may be exceedingly abrupt (Middendorff: 1867, p. 606).

Departing from the coastal districts inland into the mountain ranges, *L. Gmelini* is again found growing in the most inaccessible spots and in the very highest tree-clad regions. In the north this fact is very pronounced, the only other tree accompanying it to its highest points of growth being the low, creeping *Pinus pumila;* Middendorff has supplied an exhaustive description of this circumstance in the Stanowoj Range, especially in the district around the source of the little Ujan River, 1200 m. above sea-level (l. c. 1867, p. 616).

Further south, indeed, the larch contrives to force its way high up among the mountains, but only occurs scattered among *Abies sibirica* and *Pinus cembra* var. *sibirica* at the extreme limit, which, on Sokondo, south-east of Lake Baikal, reaches 2000 m. above sea-level (Radde in Baer & Helmersen: Beitr. Kennt. Russ. Reich. XXIII, 1861, pp. 468—472. Vide Middf. 1867, p. 622).

L. Gmelini is thus the dominant tree, outnumbering all others far northwards out upon the flat, wet tracts, and in part also, upon the upper tree-clad mountain regions, and, finally, outwards to the coast, but it by no means

attains its best development in these localities. The protected spots on the slopes of vallies with the fresh, well-drained soil are those where the finest examples are found, even though they appear to demand a greater degree of humidity on the more southerly than the more northerly situated localities (MAXIM. 1859, pp. 393—394, and MIDDF. 1867, p. 540). The fact that *L. Gmelini* is most common in localities shunned by other trees, is in agreement with its light-loving characteristic. It may be expressed as follows: it is excluded from richer soil by coniferous trees more tolerant of shadow (*Abies sibirica, A. sachalinensis, Picea obovata, P. jezoensis, P. Glehnii, Pinus silvestris, P. cembra var. sibirica,* and *P. pumila*), and is only deserted by them under the most unfavourable growing conditions, which the larch has greater capabilities of withstanding than the other species. *Pinus pumila* is its closest competitor, and may perhaps even be said to surpass it with regard to the elevations at which it can exist.

TRAUTVETTER's first detailed description of *L. Gmelini* with illustrations is based upon specimens collected by MIDDENDORFF near Novaja at lat. 72½° N., and thus originates from „Die an der äussersten Baumgränse stehende Lärche des Taimyrlandes", as MIDDENDORFF himself expresses it (l. c. p. 748, Note), that is to say, from the same region as MIDDENDORFF's illustration (reproduced here) of the most stunted specimen. A just estimation of *L. Gmelini* as a valuable forest tree widely distributed in Eastern Siberia, and not merely as a dwarf growth on the forest-line towards the Polar Sea, as MAYR still regarded it when he described the larch on the Kurile Islands (MAYR: 1890, p. 99), has been arrived at from the descriptions given by MIDDENDORFF himself, and from the accounts of

Maximowicz, Fr. Schmidt, Wilson, Miyabe & Kudo, Okada, and others. Beyond varying in its form of growth, *L. Gmelini* evinces certain modifications in other particulars, but never to such an extent as to warrant their not being included under one species within the limits adopted in the present paper; it must, nevertheless, be regarded as one of the most variable species of the genus Larix.

Fig. 14. *L. Gmelini.* (Rupr.) Gordon, small coned (so-called *L. kurilensis* Mayr). Cones from cultivated tree. Denmark, Egelund plantation 1923. (Nat. size, upper row dry, lower row wet.)

The cones may vary in size from quite short (1 cm. or less Fig. 14—15) to almost double the size (2 cms.), but all possess the characteristic straight cone-scales, not incurved, but rather sligthly recurved, truncate or emarginate at the free edge. The straight cone-scales give the cone a characteristic appearance of lightness, specially pronounced in the case of dried specimens.

The one-year's shoots vary from reddish-brown to light coloured, and their degree of pilosity, often very pronounced, varies likewise, and may be completely absent. Reddish-brown and distinctly pilose shoots are stated by Mayr as being characteristic for the larch on the Kurile Islands, and this was generally accepted, until the exhaustive investigations of Miyabe & Kudo (1920, p. 24) showed that this fact alone did not warrant the differentiation between the larch on the Kurile Islands an that on Sachalin. Mayr also described the larch on the Kurile Islands as possessing purple-red female cones when flowering, but Miyabe & Kudo, in common with Wilson, have shown that the flowers of

the Larix on the Kurile Islands and Sachalin were not constant in colour, but that the bright, green colour could also occur (MIYABE & KUDO: Plate 7; and *f. ochrocarpa*, WILSON 1916). It is possible that the one-year's shoots of the larch in Kamtschatka, the Kurile Islands, Sachalin,

Fig. 15. *L. Gmelini* (Rupr.) Gordon. Cones from cultivated specimens. Denmark, Forestry Botanical Gardens, Charlottenlund, 1922. ($^3/_4$ nat. size, upper row dry, lower row wet).

Skantar, other lesser islands, and tracts of coast of the mainland, are rather more reddish-brown, and that the colour of the female cone is more often red there than in other localities, but there is not sufficient basis to warrant this larch being classed as a separate variety, and still less for the retention of a distinct species, viz., *L. kurilensis* MAYR.

There is likewise no reason for separating MAYR's *L. Cajanderi* from *L. Gmelini*. The "dichter weissgelber, lockiger Haarschopf", which appears simultaneously with the new leaves, has the same form as that described for the cone-scales of *L. Gmelini*, and there is no deviation in other particulars. MAYR stated that is was found scattered among *L. Gmelini*, along the course of the Lena, from the outlet

of its tributary, the Aldan River, and still farther northwards, *L. Gmelini* occurring alone to the south of it. Mayr based his opinion upon material collected by Cajander in the course of his journey along the Lena from its source to its estuary; but Cajander himself described all the larches along the lower course of the Lena as *L. Gmelini.* Comparing Mayr's illustration of *L. Cajanderi* (Fremdl. Wald und Parkb. 1906, Fig. 88) with Trautvetter's *L. dahurica* (Pl. Imag. Descrip. Fl. Russ. Ill. Fasc. 7, 1846, Plate 32), one may well go so far as to say that Mayr's specimens represent a very typical *L. Gmelini*; it originates, moreover, from a northerly locality (North of lat. 63° N.) similar to that from which Trautvetter derived his material (lat. 72½° N.).

L. Gmelini is stated to have been introduced into Europe in 1827, and put into culture in Denmark in 1889 (or earlier), where attempts have been made to utilise it in the forests (A. Oppermann: 1923, p. 271). To judge by its occurrence on the cold, foggy coasts of the sea of Ochot, it is reasonable to suppose that it possesses forest-forming capabilities in other unfavourable localities, of which we have a pronounced example in the Faeroe Islands.

Besides the variations which we do not think are worth keeping as special varieties (*L. kurilensis* and *L. Cajanderi*), the species-complex *L. Gmelini* has two geographical varieties of more systematic value, viz., *var. olgensis* and *var. Principis Rupprechtii*, both of which occur south of the area of occurrence of the real *L. Gmelini.*

Herb. Mat. examined:

Ad. fluv. Boganida 72½°, Middendorff (Hort. Bot. Haun.); type collection to *L. dahurica.* — Sib. Orient. Udskoi, Exp. Acad. 1844 (Kew). — Ochotsk Sea, C. Wright, Coll. U. S. Explor. Exp. 1853—56 (Kew). — Amur, Maximowicz, ex Herb. Hort. Petropol. — Maximowicz, Iter secund, 1860. Manchuria austro-orient. ad. fontes fluv. Fundim (Kew). — Manschur.

austr. orient. ad Usuri sup., c. 1860, MAXIMOWICZ (Brit. Mus.). — Jap. Hakodate, cult. MAXIMOWICZ, Iter secund. 1861. — (Kew) Dr. ALBRECHT, Jap. Ins. Jezo circa Hakodate, 1861 (Kew). — Sachalin, FR. SCHMIDT (Kew). — Ad. flum. Kolyma, leg. AUGUSTIMOWICZ (Kew). — Sibiria, SCHOCKLEY, 1900, a) Cape Suffein b) Turumcha Crest (Brit. Mus). — Kaborowsk, C. S. SARGENT, 1903 (Kew). — Border of swamps near Srychensk, C. S. SARGENT, Aug. 1903 (Arn. Arb.). — SACHALIN, 1907, FAURIE (Brit. Mus.; Arn. Arb.). — V. KOMAROW, Iter Kamtschatic. secund. leg. V. KOMAROW, No. 247, 1909 (Kew). — Kamtschatka, V. KOMAROW, Iter Kamtsch. secund. 1909 (Kew). — Prov. Transbaicalia, sept. lacus Baical. Herb. Fl. Ross. 1912 (Hort. Bot. Haun.). — Sachalin, 1914, E. H. WILSON, No. 7364 (Brit. Mus.). — Sachalin, 1914, E. H. WILSON No. 7331: *L. dahurica* var. *japonica* f. *ochrocarpa*, WILSON (Brit. Mus.). — Tschapina, Nikolki, Kamtschatka, leg. R. MALAISE, 1921, Svenska Kamtschatkaexp. No. 3468 (Hort. Bot. Haun). — Open country near Togoliara shrine, Sachalin, 1914, E. H. WILSON, No. 7333 (Arn. Arb.). — Cult. HEINRICH MAYR, Grafrath, Bayern, 1927, C. SYRACH LARSEN (Hort. Bot. Haun.). — Det forstlige Forsøgsvæsen, Egelund Planteskole, Denmark. — Copenhagen, Bot. Gardens. — Forestry Botan. Gardens, Charlottenlund, Denmark.

7 b. **Larix Gmelini, var. olgensis** (Henry *1915*) OSTF. & SYRACH L., in Pflanzenareale. II. 7. *1930*.

Syn.:

Larix sibirica, MAXIMOWICZ, 1860, in herb. et apud KOMAROW, in Act. Hort. Petrop. XX, 1901, p. 194. — PATSCHKE in Engl. Bot. Jahrb. XLVIII, 1913, p. 692. — Non LEDEB.

Larix dahurica, KOMAROW, in Act. Hort. Petrop. XX, 1901, p. 190. — NAKAI, in Journ. Coll. Sci. Imp. Tokio, 1911, p. 382. — Non TRAUTV. —

Larix olgensis, HENRY, in Gard. Chron. 27. Febr. 1915, and in Trans. Roy. Scot. Arb. Soc. 1915, p. 147. — KOMAROW, in Act. Hort. Petrop. XXXIX, 1923, p. 23 et 126. — DALLIMORE & JACKSON: Handb. Conif. 1923, p. 295. —

Larix koreensis, RAFN, nomen nudum, in Tidsk. f. Skovv. XXVII, 1915. — O. G. PETERSEN: Forstb. 1920, p. 247. — A. OPPERMANN in Det forstl. Forsøgsv. i Danmark, VII, 1923, p. 273. —

Larix dahurica, var. *koreana,* NAKAI, in TOZAWA & NAKAI, Atlas ill. geogr. Distrib. of Korean woody Plants & Bamboos. I. 1. 1929.

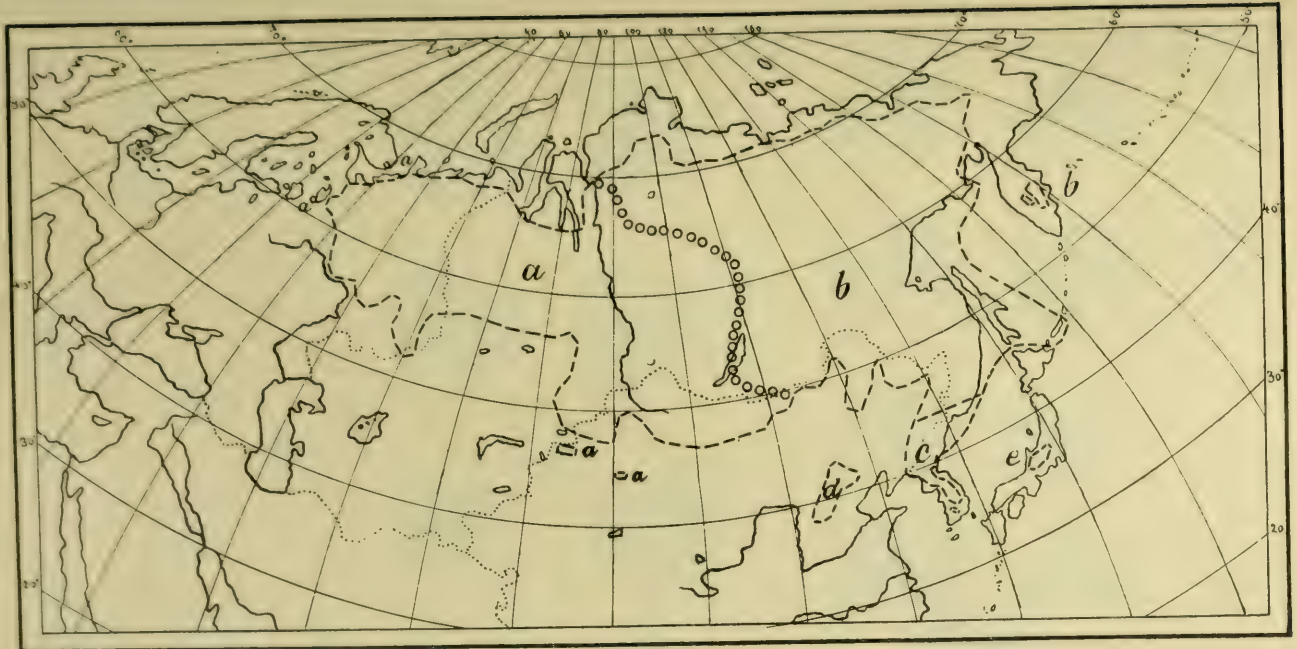
In 1860, MAXIMOWICZ found a larch near Olga Bay on the coast of the Amur district, which he classified as *L.*

sibirica. It was subsequently described by Henry in 1915 on the basis of the same specimens together with fresh ones from Olga Bay as a new species, *L. olgensis.*

Map IV.

Larix Gmelini, (Rupr.) Gord.
L. G. var. olgensis, (Henry) nob.
" " " Principis Rupprechtii, (Mayr) nob.
Type Locality.

When constituting the new species, Henry specially relied upon the strongly pilose one-year's shoots, and the shape of the cone. As regards the first character, Miyabe



Map V.

a. Larix sibirica, Ledb.

b. „ Gmelini, (Rupr.) Gord.

ooooo „ Gmelini x sibirica

c. L. G. var. olgensis, (Henry) nob.

d. „ „ „ Principis Rupprechtii (May) nob.

e. „ Kaempferi, (Lamb.) Sargent.

& Kudo have shown that this pilosity of the shoots cannot be used as characteristic for the larch at Olga Bay as opposed to *L. Gmelini*, having found on Etorofu examples of the latter just as pilose. The cone is long with well-rounded cone-scales, giving it a certain superficial resemblance to that of small-coned *L. decidua* or *L. sibirica*, also to *L. Kaempferi;* it deviates to such a marked extent from the hitherto-known type of *L. Gmelini*, that there is warrant for supposing it to be a variety of the latter. It is found over a tract of country extending from Olga Bay and Vladimir Bay southwards through Kirin and the north of Korea, continuing further on the peninsula, as shown on the map (Nakai, 1911, p. 382, Tozawa & Nakai, 1929). On the north it passes over to typical *L. Gmelini*, the transition zone presumably lying in the neighbourhood of Vladivostok, but in such a manner, that *L. Gmelini* extends furthest to the south inland, while *var. olgensis* reaches furthest north along the coast. There is even a possibility that some of the large-coned Larix found on the coast around the Bay de Castries and the mouth of the Amur by Maximowicz in 1854 ought to be classified under this variety. Maximowicz first classified it as *L. sibirica*, but subsequently altered his classification to *L. Gmelini* (Maximowicz: in Bull. Acad. St. Petersburg, XV, 1857, p. 226; Id., Prim. Fl. Amur., 1859, pp. 393—394).

Fig. 16. *Larix Gmelini.* Rupr. var. *olgensis* (Henry) Ostf. & Syrach L. Cone in natural size. (from Henry in The Gardener's Chronicle, Febr. 27, 1915).

L. G. var. olgensis has been cultivated in Denmark under the name of *L. koreensis*, Rafn, nom. nud., and has been shown to possess such good qualities, that the stock is being steadily increased (A. Oppermann, 1923, p. 273). The

cultivated trees show the same characteristic type of cone, the colour of the cone when flowering varying from tree to tree from red through pale pink to green; the shoots vary

Fig. 17. *L. Gmelini* var. *olgensis* (Henry) Ostf. & Syrach L. Cones from cultivated specimens[1]. Roden forest in Denmark 1922 ($^3/_4$ nat. size, two upper rows wet, two lower rows dry).

from pale to a light chestnut-brown, the majority at all events appearing to be smooth. The oldest examples known in Denmark are to be found in a plantation, Roden Forest, near Aalholm (Lolland), already mentioned in the preface.

[1] The method of photography in this illustration differs from that adopted in most of the others, and the specimens are, therefore, not well suited for comparison with figs. 16 and 18.

They were planted out in 1902 as three-year-old plants, and can be traced back to a seed-merchant in Yokohama.

Herb. Mat: examined:

Manschuriæ austr.-orient. St. Olga, Maximowicz, 1860, Type (Kew); Co-type (Brit. Mus.). — V. Komarow: Fl. Manschuriæ, No. 80, 1897, Distr. Musang, trajectus Pzao-sieng, Korea sept. (Kew). — Korea, Ma-Mihint, F. N. Meyer, 1906, No. 169 (Kew). — Arnold Arb. Exp. 1917—18: Korea, Prov. N. Kankyo, 1917, Nos. 8948, 8962, 8977 and 9044 (Snow Mt.).

Fig. 18. *L. Gmelini* var. *olgensis* (Henry) Ostf. & Syrach L. Cultivated in Denmark, Egelund Plantation, 1923. (Nat. size, upper row dry, lower row wet).

Prov. S. Kankyo 1917, Nos. 9151 and 9152 (all in Kew and Brit. Mus.). Prov. N. Kankyo, No. 8893 and 9037 (Arn. Arb.) — Culta in Dania, ins. Lolland, Roden Skov (seeds sown 1899, plants coll. 1922); ins. Sjælland, Egelund (seeds sown 1914, plants coll. 1923).

7 c. **Larix Gmelini, var. Principis Rupprechtii** (Mayr *1906*) Ostf. & Syrach L., in Pflanzenareale II. 7. *1930*.

Syn:

L. dahurica, Hance, in Journ. Bot. IV, 1875, p. 138. — Bretschneider, in Peterm. Mittl. 1876, No. 46, p. 37—39. — Masters, in Journ. Linn. Soc. Bot. XVIII, p. 522. — Patschke, in Engl. Bot. Jarhb. XLVIII, 1913, p. 706. — Non: Trautvetter.

L. sibirica, Franchet: Pl. David I, 1884, p. 97. — Patschke, in Engl. Bot. Jahrb. XLVIII, 1913, p. 706. — Non: Ledebour.

L. Principis Rupprechtii, Mayr: Fremdl. Wald- und Parkb.

1906, p. 309. — ELWES & HENRY: Trees. Gr. Brit. and Irel. II, 1907, p. 346. — DALLIMORE & JACKSON: Handb. Conif. 1923, p. 298. —

L. dahurica var. Principis Rupprechtii, (MAYR) REHDER & WILSON, 1914, in SARGENT: Pl. WILSON II, p. 21 (p.p.). — REHDER, in Journ. Arnold Arb. IV, 1923, p. 121. — REHDER: Man. Trees and Shrubs, 1927, p. 52. — HSEN-HSU HU & WOON-YOUNG CHUN: Icon. Plant. Sinicarum, 1927, Pl. 1.

Inhabiting an area which is now completely separated from that of *L. Gmelini* and *var. olgensis*, another variety of *L. Gmelini* is found, namely, var. *Principis Rupprechtii*. Its area of distribution extends over the mountains west and north of Peking through the provinces of Shensi and Chili. No forest is found north of the Yellow Sea. (Maps IV og V).

The province of Shonking, north of the Yellow Sea, was once rich in forests, which in earlier times probably formed the link between the two now widely separated forest tracts, containing respectively *L. Gmelini var. olgensis* and *var. Principis Rupprechtii*. The separation has taken place partly in recent times, and has been caused by extensive afforestation, which in that district has produced a wide extent of country devoid of forest (W. PATSCHKE in Engl. Bot. Jahrb. XLVIII, 1913, p. 705).

In 1903, HEINRICH MAYR discovered in Wutaishan, one of the most southerly localities in its area of distribution, the material on the basis of which he put forward the species *L. Principis Rupprechtii*. MAYR's cones (Fig. 94 in Fremdl. Wald- und Parkb.) are very large, and present many points of difference from those of *L. Gmelini*. The larch which WM. PURDOM found in 1909 in the same district — near some temples in the village of Wutai — has rather smaller, or much smaller, cones (Arnold Arboretum Expedition to the north-west of China, 1909, No.

161 a and 161 b), and together with other specimens, shows modifications towards *var. olgensis.*

The types of the two varieties have been taken from localities lying as far apart as possible, and for this reason it is only natural that careful investigation within the

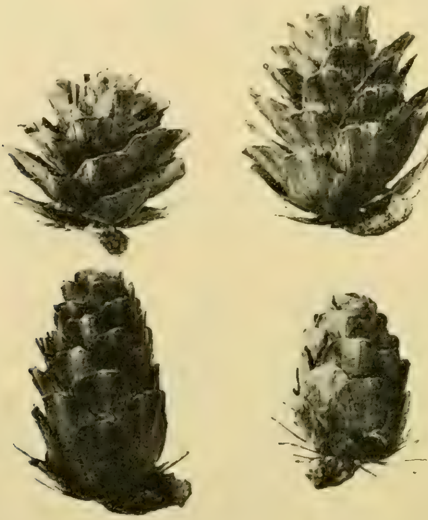


Fig. 19. *L. Gmelini* var. *Principis Rupprechtii* (Mayr) Ostf. & Syrach L. China, Shansi, Wutai village (leg. W. Purdon, 1909), (large-coned). (Nat. size, upper row dry, lower row wet).

radius of distribution has led to the discovery of material showing less pronounced differences than the types, but which, on the other hand, illustrate the transitional stages from the one to the other.

Breitschneider found *var. Principis Rupprechtii* during his ascent of the mountain Po-hua-shan on the west of Peking, where, apart from its having been planted near the temple on the summit of the mountain at a height of about 2200 m. above sea-level, it was also found scattered on the slopes of the mountain (Peterm. Mittl. 1876, No. 46, pp. 37—

39). MAYR's account of its occurrence in 1903 includes an isolated specimen near a temple, and some old trees on a slope of a neighbouring mountain. Together with these, the oldest, accounts, PURDOM's observations, showing that the tree has now become very rare on the mountains west of Peking (Pl. Wils. II, p. 21), give the impression of a rapidly declining tree, and one which, at any rate, is now found for the most part scattered in the higher mountain regions, 2000—3000 m. above sea-level.

Neither does it appear to be a particularly tall tree, the greatest dimensions given being 20—25 m. high with a girth of 2 m. The cone is cylindrical, being longer, and possessing considerably more cone-scales, than either *L. Gmelini* or *L. G. var. olgensis.* The shape and number of the cone-scales are reminiscent of *L. sibirica,* with which FRANCHET also classified it on the basis of DAVID's specimens. It differs, however, quite distinctly from *L. sibirica* in its smooth, thinner cone-scales, which are not incurved along the free margin, and are more openly arranged, thus giving the cone that appearance of lightness and openness characteristic of *L. Gmelini* and its varieties, and which is especially apparent when dry. MAYR's cones, which seem to be of unusual size, are 4,2—4,3 cms. in length; cones from 2400 m. above sea-level in Wutai-shan (PURDOM, No. 161 b) are 2—3 cms. long, while others from 2550 m. above sea-level in the same district are only $1^1/_2$—$2^1/_4$ cms. in length, but they are all more slender and narrower in comparison with the length than the cone of *L. Gmelini.* The, relatively, still larger size of the cone is the only point of difference between it and *var. olgensis.* The cone when flowering is red with a pale midrib in the bracts, according to WM. PURDOM's specimens in the U. S. National

Herbarium, but other information with respect to the colour is lacking. This larch is not found in cultivation in Denmark, where everything bearing a resemblance to it almost certainly has its origin in Korea, and belongs to *var. olgensis.*

Dallimore & Jackson (Handb. Conif. 1923, p. 298) are incorrect in citing Rehder & Wilson as the authors of the species *L. Principis Rupprechtii;* Rehder & Wilson were the first to classify it as a variety of *L. dahurica,* while Mayr must still be accounted the author of the species, if it is to be maintained as such.

On the occasion of the Arnold Arboretum Expedition to the East in 1917—1918, Wilson discovered a larch with a peculiar cone, which he has named *L. dahurica var. Principis Rupprechtii f. viridis.* Two trees of unknown origin have been planted near the monastery of Yutingi in Kongosan in the province of Kogan in Korea. The cones of the specimen lying before us (No. 10508) vary in length from 2,5 to 3,5 cms., and in breadth from 2,3 to 2,6 cms. (open and dry). The cone-scales are faintly emarginate, of a reddish-brown colour, with a distinct blue bloom. The bracts are blue-black, and are visible between the cone-scales. The light, open structure of the cone characteristic of *L. Gmelini* and its varieties is absent; in its place there is a close, solid structure which, together with the long, cylindrical cone, is reminiscent of *L. decidua.* It is impossible to come to any definite conclusion with regard to this form; further researches on the spot and cultivation are necessary.

Herb. Mat. examined:

Po hua shan, China bor. 1876, Bretschneider No. 14480 (Kew; Brit. Mus.). — Wutai shan, Wutai village, temple grounds, Shansi prov. 1909,

Wm. Purdom, Arn. Arb. Exp. N. China, No. 161 a and 161 b (Arn. Arb.; U. S. Nat. Mus.; Brit. Mus.; Hort. Bot. Haun.). — Hsiae, Wutai shan, Chili, China, 1913, F. N. Meyer (Kew). — Chili, Arn. Arb. Herb. J. Hers, Nos. 2018 and 2116 (Kew). — West-Weichang, North Chili, 1909, Wm. Purdom (Arn. Arb.).

8. **L. sibirica,** Ledebour, Flora Altaica, IV, *1833* p. 204.

Carrière: Trait. Conif. 1855, p. 274. — Trautvetter, in Middf. Reise ,I, 2'. 1. 1847, p. 170. — Trautvetter & Meyer, in Middf. Reise, I, 2'. 2. 1856, p. 88. — Herder, in Act. Hort. Petrop. XII, 1892, p. 101. — Sargent: Silv. N. Am. XII, 1898, p. 3. Note. — Köppen: Geogr. Verbr. Holzg. europ. Russl. II. 1889, p. 489. — Printz: Veget. Sib. Mong. Front. 1921, p. 112. — Elwes & Henry: Trees, Gr. Brit. and Irel. II, 1907, p. 374. — Rehder: Man. Trees and Shrubs, 1927, p. 51.

Syn:

Pinus Larix Europææ, Pallas, Fl. Ross. I, 1784, p. 1, Tab. 1, Fig. A, B, & C. —

Pinus intermedia, Fischer, in Schtschagl. Anz. f. Entdeck. 1831 (nomen nudum). — Turczaninow, in Bull. Soc. Imp. Nat. Mosc. XI, 1838, p. 101 (nomen nudum). —

L. europaea var. sibirica, Loudon: Arb. & Frut. Brit. IV, 1838, p. 2352.

L. intermedia, Turczaninow, in Bull. Soc. Imp. Nat. Mosc. XI, 1838, p. 101. (nomen nudum). — K. Koch: Dendrol. 1873, p. 260. —

Abies Ledebourii, Ruprecht in Beitr. Pflanz. Russ. Reiches, 2' Lief. 1845, p. 56. —

Pinus Ledebourii, Endlicher: Syn. Conif. 1847, p. 131. —

L. decidua var. Rossica, Henkel & Hochstetter: Syn. Nadelh. 1865, p. 132. — Regel in Gartenfl. XX, 1871, p. 101, and in Act. Hort. Petrop. I, 1871, p. 157. —

L. decidua, var. sibirica, Regel, in Gartenfl. XX, 1871, p. 101, and in Act. Hort. Petrop. I, 1871, p. 156. — Korshinsky, in Mém. Acad. Imp. Sci. Mosc. 8' Ser., VII, 1898, p. 493. —

L. Rossica, Trautvetter, in Act. Hort. Petrop. IX. 1884, p. 212.

We have seen the manner in which *L. Gmelini* occurs in Eastern Siberia; *L. sibirica* presents the parallel in Western Siberia and the north-east of Russia, where it is a common forest tree. Its area of distribution extends unbroken from Lake Baikal in the east to the White Sea,

terminating in the west quite near to Lake Onega (Cajander). Its most northerly point reaches Jenisej, where, according to Scheutz (1888, p. 41), it is to be found right up to the Arctic Sea (see under *L. Gmelini* in this paper, p. 40). From this point, lat. 69°—70° N., it may be found growing everywhere southwards to the Altai Mountains, and the area reaches its southern extremity in two isolated localities a little more to the south on the southern slopes of the Sair Mountains at lat. 46°—46½° N. and near lat. 45° N. (Price & Simpson in Journ. Linn. Soc. Bot. XLI, 1913, p. 444). On the south-east point of the Kola peninsula there is an isolated, presumably wild, specimen. It is about 3½ m. in height, and is supposed to be more than 150 years old. It is situated 3 km. from the sea, and 2 km. from Ssosnowka (Tolmatchew in Sv. Bot. Tidskrift, 1925, p. 523). (See Map V).

The border-line of its occurrence has been drawn on the map according to several different sources. In European Russia, Kouznetsov's revision of Köppen's map has been adhered to in the main (Köppen; Geogr. Verb. Holz. 1889, Map IV, and Kouznetsov in "vol. jubil. à I. P. Borodin" 1927) (see our Map VI), and also Blomqvist (Finsk Forstf. Medd. 1887, pp. 152 and 153). Towards the east, more particularly north of the Urals, the line has been extended farther out towards the Arctic Sea in agreement with Middendorff (Midd. Reise, IV, Part I, p. 531), who gives the most northerly point of occurrence in Europe as being about the source of the Kara in the extreme north of the Urals at lat. 68° N. Further eastwards, the boundary is likewise Middendorff's (l. c. pp. 531—532), and has only been moved close to lat. 70° N. near Jenisej, as already stated, in conformity with Scheutz, Middendorff having placed it a little more to the south, attributing the occur-

Map VI.

rences of larch in the extreme north to *L. Gmelini* (for which we refer to *L. Gmelini*). Towards the east, it is bounded by the belt of intermediate forms, also mentioned under

L. Gmelini (*L. Czekanowskii*, Szafer), and we find the reports of the most easterly occurrence of *L. sibirica* within this belt, where Cajander found it on the Lena almost as far east as Oleminsk (Act. Soc. Sci. Fen. XXXII, No. 3, p. 8). In a southerly direction, it has been collected in the forest east of Urga and north of the river Tola (C. W. Campbell, 1902, Kew Herb.). In determining the borderline towards the south, we have the exhaustive reports of Printz (Veget. Sib. Mong. Front. 1921), and the already-mentioned observations of Price & Simpson for the eastern section; but from this point, where we are without their observations in the south of Russian Siberia, and until we reach European Russia, special investigations regarding the larch are lacking. The most probable boundary is the one given here (according to Zon & Sparhawk: Forest Resources of the World, 1923, p. 286), as it undoubtedly everywhere constitutes one of the farthest-reaching forest outposts. Its occurrence in the Urals has been investigated by both Köppen and Korshinsky, and their observations, have been followed here. Their statement, that *L. sibirica* is not to be found on the western side of the Urals towards the north right up to the source of the Petschora, has, nevertheless, been somewhat modified, the boundary having been fixed at a rather less northerly point. Köppen also mentions a more southerly line than Korshinsky. The boundary line in the southern outposts of the Urals has been drawn according to Korshinsky's and Kouznetzov's maps, which are the most detailed; the two isolated occurrences on the south-east of the Urals are included in the general are of distribution.

In the north of Russia and in Siberia, the West-Siberian larch is, as a rule, only a small tree, but along the sides

of the rivers, where it is protected, and where the soil is fresher, it may develop better; in the extreme north, however, where it occurs on the forest-line, only stunted individuals are met with (Middf. l. c.; Goredkov, 1926, Ref. in Bot. Centralbl. XX, 1927, p. 246).

In northern European Russia, the larch does not reach the forest-line, which chiefly consists of *Picea obovata*, but the situation changes as it approaches the Urals, where it becomes the only tree among the forest outposts, and this continues to be the case farther east (Rikli in Vierteljahrsschrift, Nat. Gesell. Zürich, XLIX, 1904, p. 132; vide Cajander, 1903).

The tree is of common occurrence and one of value in the entire southern area; it is seen at its best in the Urals and the mountains towards the south-east in the western part of Altai. Krassnoff (1886, Ref. in Engl. Bot. Jahrb. IX, 1888, pp. 53—67) has investigated the occurrence of the larch in the western part of Altai, and particularly discussed the problem of its natural regeneration, which only takes place with difficulty in these regions. Further towards the east in Altai, in Tannu-ola, and other portions of the extreme north-west of Mongolia, its occurrence has been described by Price & Simpson (l. c. pp. 391–398). The best and most recent description of the West-Siberian Larch in its natural surroundings is Printz's detailed account of its occurrence and development in Tannu-ola and the Sajan Mountains and the adjacent steppes. The area is an interesting one, the larch being described in all its forms, from the highest development in the fertile, fresh mountain-soil, to its isolated, decrepit appearance on the steppes.

Under the most favourable circumstances, it may attain a height of over 40 m. with a diameter of about

1,5 m. A warm, fresh soil is especially favourable to its growth, and in such localities it forms more or less pure groups, while it is otherwise met with in forests scattered among *Pinus silvestris, Picea obovata, Abies sibirica*, and *Pinus cembra var. sibirica.*

On the forest steppes the larch is the dominating tree. On the steppe between the Sajan Mountains and Tannu-ola, small sporadic specimens of the larch are found along the upper course of the River Jenisej. West of the Sajan Mountains, on the Abakan steppes, it is found where the ground rises in low ridges, and it also occurs along the courses of the rivers and on the small islands lying in their beds. Here it is often mingled with *Pinus silvestris*, birch (*B. pendula)*, and poplar (*P. laurifola, P. tremula*, and *P. nigra*) (Printz, 1921, p. 112). Good illustrations of *L. sibirica* are to be found in Printz's book, and in B. A. Keller's paper: Im Berg und Tal des Altai I, 1914, Plate 5 (see Fig. 20).

Of the other species of larch, *L. sibirica* most resembles *L. decidua*, of which it has sometimes been regarded as a variety (Loudon, Regel, and Korshinsky).

In the absence of flowers or cones, they are also difficult to distinguish; their leaves are similar, although those of *L. sibirica* are somewhat longer than those of the latter; the light-coloured bark is another point of resemblance.

Under cultivation, the young tree of *L. sibirica* is characterised by its crown, which is remarkably narrow, but the young tree is perhaps most easily recognised by the sweet, pleasant scent which becomes apparent under dry conditions, and which is not found in the European larch.

The cone of *L. sibirica* is, when flowering, green, or

faintly rose-coloured, varying to a deeper red, in which case the colour approaches that of *L. decidua.* Material taken from the province of Irkutsk (Herb. Fl. Russ, 1907,

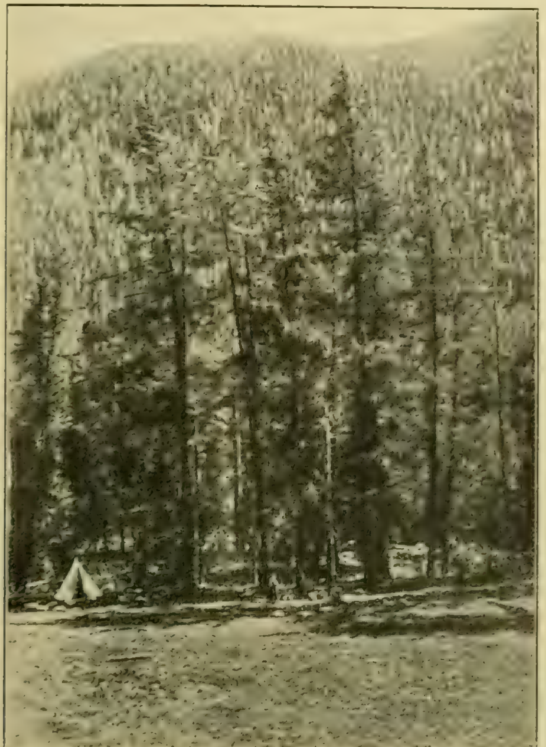


Fig. 20. *Larix sibirica* Ledeb. Trees of good size from Altai. (From KELLER, Altai I. 1914).

No. 2545), and from a forest east of Urga and north of the river Tola in Manchuria (C. W. CAMPBELL, 1902, Brit. Mus.) shows flowering cones of just such a colour, but, as a rule, they are of a lighter red, or almost green. The cone is 3—4,5 cms. long, composed of numerous scales, 30—40 in number, and is in this particular reminiscent

of the cone of *L. decidua* or *L. Gmelini var. olgensis.* Its incurved cone-scales, with their inflexed free margins nevertheless constitute *L. sibirica* a well-defined species, and its characteristics do not appear to vary much,

Fig. 21. *L. sibirica* Ledeb. Kuretj on the western side of Lake Baikal, in mixed forest, leg. Sukatschew, 1928. (Nat. size, upper row dry, lower row wet).

although it shows some transition into *L. decidua* in the most westerly area of occurrence, *L. decidua var. polonica* being a stage approaching *L. sibirica.* The outer-side of the cone-scale is, moreover, faintly pilose to closely matted, chiefly at the base. At maturity, the cone-scales open more than is the case with *L. decidua,* but not so much as *L. Gmelini,* and the wing of the seed does not reach quite as far as the free margin of the cone-scale.

L. sibirica was introduced into Denmark by SCHÄFFER, and it was planted in the Castle Garden at Hørsholm in 1796 (A. OPPERMANN, 1923, p. 257), but is has never become common, although it is to be found in several dendrological collections, and experiments are still being made with it in forestry, but on the whole it does not seem to grow well with us, and is usually strongly attacked by *Dasyscypha Wilkommi.*

Herb. Mat. examined:

Altai, LEDEBOUR (Kew). — Altai (Brit. Mus.). — Sasan Gebirge, Chonna Engate, STUBENDORFF 44. (Brit. Mus.). — Little Atlim and Jumbemjol, Siberia, c. 1880, CH. HAGE (Hort. Bot. Haun.). — East Mongolia, forest E. of Urga and N. of Tola River 1902, C. W. CAMPBELL (Brit. Mus.). — Prov. Irkutsk, distr. Balagansk, in insula fl. Angara pr. Sczerbaczewa, 1907, Herb. Fl. Ross., Mus. Bot. Acad. Imp. Petropol. edit. (Hort. Bot. Haun.). — Mongol & Turkestan Exp. 1910, M. P. PRICE, Gloucester. Kobdo River, Mongol.; several other specimens from the same Expedition without locality (Kew). — KASNEZKY, Alatau reg. flum. Tom. 1909, B. KLOPOTOV (Kew). — Pl. of Siberia, F. N. MEYER. Near Sajansk, S. W. Siberia, 1911 (Kew). — Pl. of Siberia, F. N. MEYER. Near Ak-selan, Altai 1911, (Kew). — St. Irkutsk, W. SUKATSCHEW, 1928 (Hort. Bot. Haun.). — The Bays Kurkut and Koty, Mt. Chargana and at the village Kuretj, all on the western side of Baikal lake, W. SUKATSCHEW, 1928 (Hort. Bot. Haun.).

9. **L. decidua**, MILLER: Gard. Dict. 8'. *1768.*

K. KOCH: Dendrol. 1873, p. 258. — KIRCHNER, LOEW & SCHRÖTER: Lebensgesch. Blütenpfl. Mitteleuropas I, 1906, p. 155. — REHDER: Man. Trees and Shrubs, 1927, p. 51. —

Syn:

Pinus Larix, LINNÉ: Spec. Pl. 1753, p. 1001. — LEDEBOUR: Fl. Ross. III, 1846—51, p. 672. —

Abies Larix, POIRET in LAMARCK: Dict. VI, 1804, p. 511. —

L. europæa, DE CANDOLLE in LAMARCK: Fl. Franc. III. 1805. p. 277[1]. — CARRIÈRE: Trait. Conif. 1855, p. 276. — ELWES & HENRY: Trees, Gr. Brit. and Irel. II, 1907, p. 349. — BEISSNER: Nadelholzk. 1909, p. 311. — DALLIMORE & JACKSON: Handb. Conif. 1923, p. 281.

[1] On the title page is given 1815, but it should be 1805; according to a note from A. DE CANDOLLE. Conf. ELWES & HENRY, II, 1907, p. 349. Note. —

Larix larix, Karsten: Pharm. med. Bot. 1882, p. 326. — Sargent: Silv. N. Am. XII, 1898, p. 3. Note. — Ascherson & Graebner: Synop. 2'. I, 1913, p. 313.

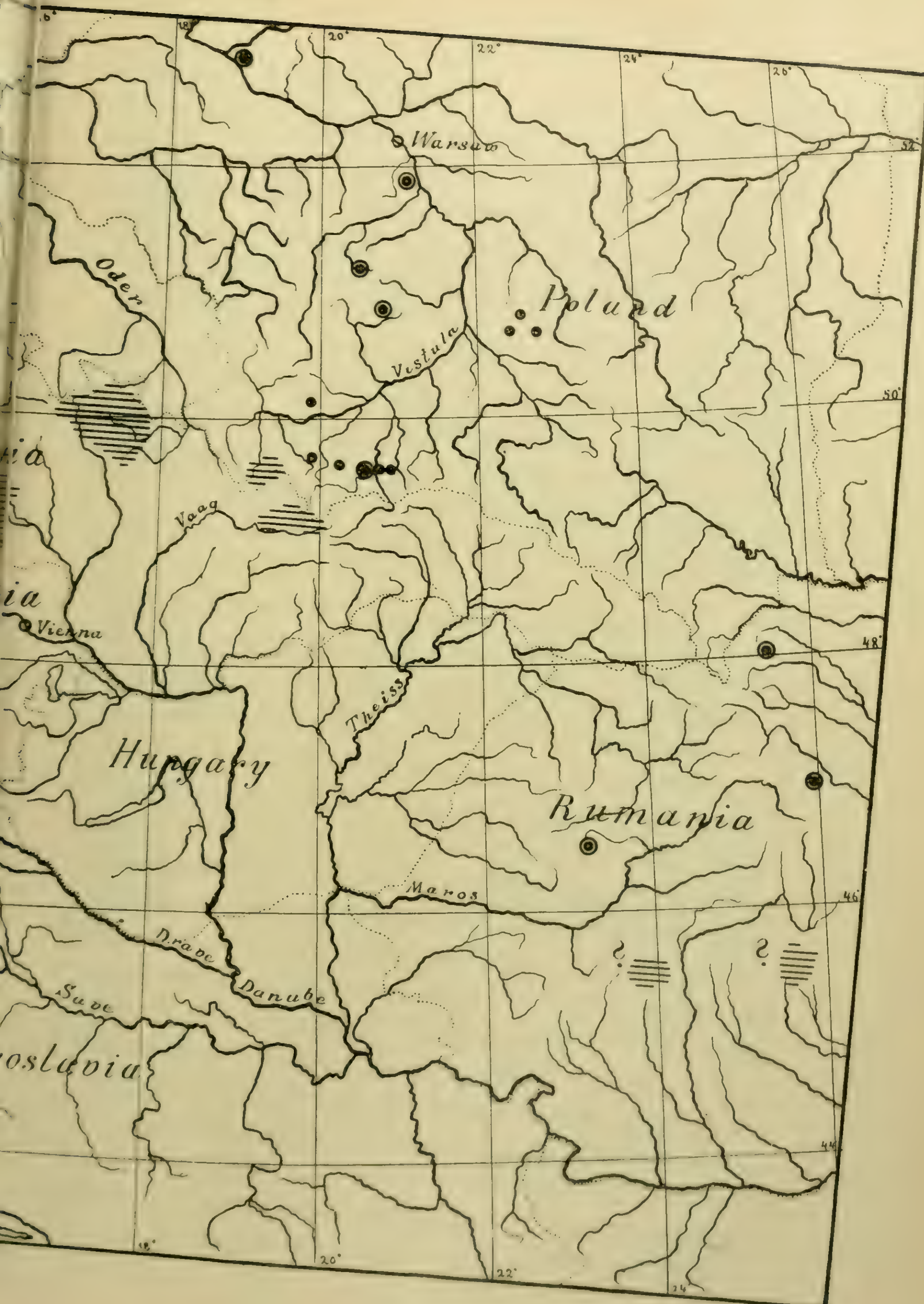
The European Larch, *L. decidua*, extends from Dauphiné and Provence northwards and eastwards through the Alps to a point 40—50 km. south-west of Vienna, where its main area of occurrence reaches the most extreme northwesterly point. In the north-west corner of Yugo-Slavia and the north-east corner of Italy it reaches southwards to lat. 46° N., extending to lat. 44½° N. in the west (Willkomm: Forstliche Flora, 1887, p. 144), and probably even a trifle further southwards to between lat. 44½°—44° N. It also occurs spontaneously towards the north-east in the southern district of the Sudetic Mountains and Tatra, and there may be two isolated localities in the Transylvanian Alps.

The occurrence of the larch in the French Alps has been mentioned sufficiently frequently (Grenier & Godron: Fl. France, III, 1855, p. 156; Honoré Ardoine: Fl. Alp. Maritim, 1867, p. 346; Rouy: Fl. France, XIV, 1913, p. 359), but a detailed description, such as, for example, Christ's account of the species in Switzerland, is wanting. It is found in Savoy, Dauphiné, and in the Provincial Alps and no doubt extends somewhat into the Maritime Alps, its southern limit being probably, as already stated, between lat. 44° and 44½° N. Briquet's account of the larch in the French Alps which approach the Lake of Geneva (Briquet in Ann. Conserv. & Jard. Génève, III, 1889, pp. 46—146), indicates an occurrence in larger or smaller quantities at an elevation of 600—1800 m. above sea-level, and points to the fact that the natural forests have been greatly over-exploited, and finally, that it is

partly being superseded by other kinds of trees. In all probability, a similar state of affairs holds good for its distribution in a southerly direction, where it is nevertheless found growing higher up in the mountains. Thus it is found forming dense woods at an elevation of 2300 m., and can be seen in small groups as high as 2400—2500 m. above sea-level (Flahault in Coste: Fl. France, I, 1901, and in Rev. Eaux et Forêts, 1901).

The border-line of distribution in the present paper has been drawn in accordance with Christ's map of the occurrence of the larch in Switzerland (Christ: Pflanzenl. Schweiz, 1879, Map II), and is continued in an easterly direction in conformity with the statements of Kerner and Cieslar (Kerner: Pflanz. Donauländer, 1863, and Cieslar in Centralbl. Forstw. 1904, pp. 2—9). Of these the latter is one of the most recent and detailed descriptions of the geographical distribution of the European Larch, and is the work which has been most closely adhered to here. The small area of occurrence north of the Danube near Pöggstall and Jaurling has, nevertheless, been included on the authority of Kerners' positive statement that it grows wild in this locality (Kerner: l. c. p. 158). The area of distribution in Czeko-Slovakia on the south-easterly frontier of Bohemia, and the south-easterly portion of the Sudetic Mountains, is drawn according to Cieslar and Hayek (Hayek: Die Pflanzendecke Österr. Ung. I, 1916). Hayek remarks, that it is hardly possible to define with any degree of certainty the area of distribution where the larch grows wild, and the same is undoubtedly the case with regard to the other area on the Bohemian frontier. There appears, however, to be no doubt that the larch exists in the wild

Larix decidua, Mill.
L. d. var. polonica, (Raeib.) nob.
Natural Forest.
Single Specimens.



Warsaw
Oder
Poland
Vistula
Vaag
Vienna
Hungary
Theiss
Rumania
Maros
Drave
Danube
Save
oslavia

state in both these areas; the only point of uncertainty is the extent of the two localities in question.

Of the two smaller localities still further eastwards, the most southerly lies in Tatra, where the larch occurs scattered on the slopes towards the valley of the Waag (Cieslar: l. c. p. 4; Hayek: l. c. pp 343 and 395; and Sagorski and Schneider: Fl. Centralkarpathen, I, 1891, p. 569). The forest-line here is formed of stunted larches, which in the highest parts grow at an elevation as high as 2000 m. above sea-level. The other locality north-west of Tatra lies in Babia góra on the frontier between Czeko-Slovakia and Poland (Vierhapper in Öster. Bot. Zeitschr. LXI, 1911, p. 229. Vide Cieslar in Centralb. ges. Forstw. XL, 1914. p. 182, Note).

Beyond the area of distribution mentioned here, *L. decidua* has also been reported far out towards the south-east in the Transsylvanian Alps, where Hayek cites two localities, one to the south (see Map VII), and the other to the west of Kronstadt, in the Cibin Mountains, where it is found in the neighbourhood of the Zood valley at an elevation of 1400 m. above sea-level and upwards. The first-mentioned locality has also been described by Maack (Zeitschr. Forst. Jagdw. XXXVI, 1904, p. 644), who gives a detailed account of forest remains, including specimens of considerable dimensions in the mountains, growing at altitudes from 1300—1600 m. above sea-level, and mentions that timber for the castle at Sinai was fetched from this spot. The larch in both these localities is undoubtedly the original species; the only point not decided being whether the tree is the typical *L. decidua*, as there seem to be reasonable grounds for believing that it may be *L. d. var. polonica*.

The colour of the young shoots and the colour of the

leaves is reminiscent of the West-Siberian Larch, which, in the coneless state, is most easily distinguishable from *L. decidua* by the scent of dried specimens, absent in the case of the latter, as mentioned under *L. sibirica.* The young shoots are smooth and yellowish, the leaves 2—3 cms. long, of a fresh, green colour. The bracts, which are of a deep purple-red are, during the flowering season, much longer than the green, or faintly red, cone-scales, which they entirely cover. This purple-red colour is absent from the bracts only in exceptional cases, the whole female cone being then green or whitish instead. The last-mentioned form (*flore albo*, Loudon, 1838) is found in Wallis, the Engadine, and in the neighbourhood of Flühelen in Switzerland (Christ: l. c. p. 225; Asch. & Graeb. l. c. p. 314). The cone is long and cylindrical, consisting of a large number of scales — 30 to 40 — and is generally 2,5—4 cms. long, but specimens as long as 6 cms. have been collected by Coaz in the Münster valley at Graubünden (Beissner: 1909, p. 312, Note). The cone-scales are straight and thin at the free margin, which is broad and rounded, or slightly incurved. The seed-wings are as long as the cone-scales, and reach their extreme edges, so that they are, relatively, a trifle longer than in the case of *L. sibirica.* The exterior of the cone-scales is smooth or pilose, but seldom so pronounced as in the case of *L. sibirica*, and the bracts of the mature cone are visible at the extreme base of the cone, being wholly covered on the other parts.

During the younger period of growth, the tree is pyramidal in shape, but the appearance becomes less pronounced the older it becomes. The bark of old trees becomes furrowed, and sheds in larger or smaller plates, thus exposing portions of the reddish-brown inner bark. The heart-wood is

handsome, strong, and of great durability; its value is further increased by the trunk being frequently straight,

Fig. 22. *L. decidua* Mill. Cones of cultivated specimens from Denmark, 8 different collections ($^3/_4$ nat. size, all wet).

and often attaining considerable dimensions. The greatest height observed is presumably 53,7 m., or perhaps a trifle higher (Oppermann: 1923, p. 216; vide Elwes & Henry: II, 1907, p. 349). The corresponding diameter was 1,1 m.,

which indicates a well-formed tree, but far greater girths combined with less height have been observed.

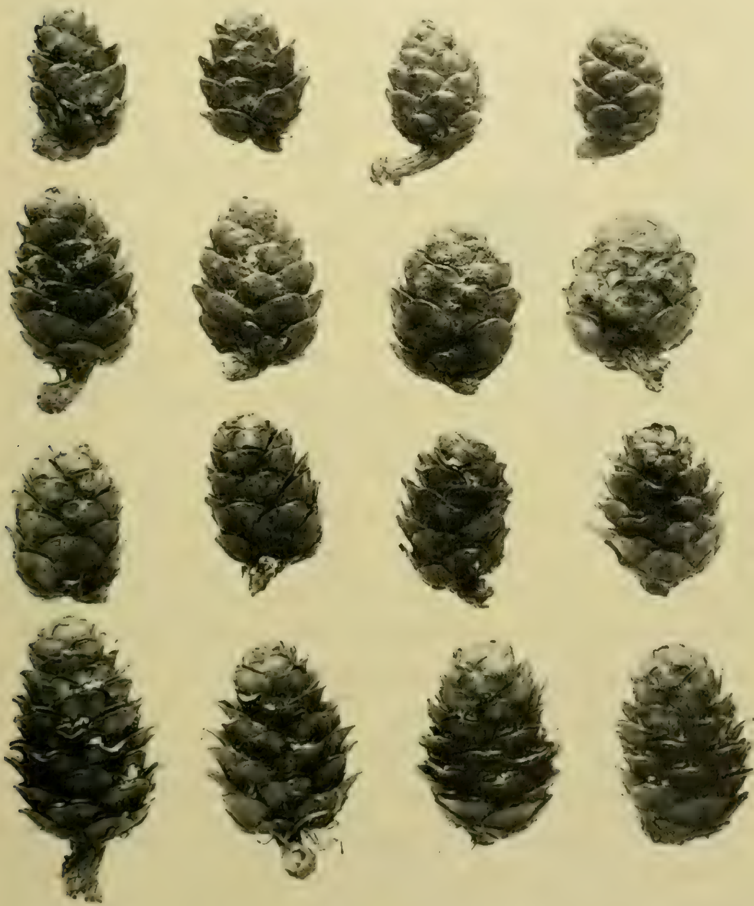


Fig. 23. *L. decidua* Mill. Cones of cultivated specimens from Denmark, 8 different collections. ($^3/_4$ nat. size, the same cones, all dry).

L. decidua often varies in its growth, and several well-pronounced forms have been found — pendulous, globular, and so on —. Cieslar has differentiated the larch found in the Sudetics as a separate form with more slender trunk

and crown, thinner branches, later leafing, and earlier fall (Cieslar: l. c. 1914, pp. 171—174; vide Schreiber in Centralb. ges. Forstw. 1921, p.p. 1—30 and pp. 76—99), and the larch which has been grown in Scotch forests for the last two hundred years is also regarded as a separate form with good qualities from the forestry point of view (G. Schotte, 1917; A. Oppermann, 1923). The height of 53,7 m. with a corresponding diameter of 1,1 m. was found at Jägerndorf in the south of the Sudetic Range, which shows it to have been discovered within the area indicated by Cieslar as being the district for the good Sudetic Larch.

The European Larch is one which has been cultivated for a long period; it was introduced into Danish forests by v. Langen in 1763, or even perhaps in 1745, and is now a common forest tree. One of the finest plantations is to be found in Tinghus Plantation in Grib Forest. It originates from 1777, and in 1923 the largest tree had attained a height of 34,5 m. with a girth of 85,5 cms. 1,3 m. above the level of the ground, this and other trees in the plantation being of particularly good shape (A. Oppermann, 1923).

Herb. Mat. examined:

Numerous cultivated specimens from Denmark, Sweden, Norway, Scotland, North America etc., in different herbaria.

9 b. **L. decidua, var. polonica** (Raciborski *1890*) Ostf. & Syrach L., in Pflanzenareale II. 7 *1930*.

Syn: *L. polonica*, Raciborski: Kilka slow omdrzewiu w Polsce, (Einiges über die Lärche in Polen) 1890, and in Z. Woycicki: Obrazy reslinnosci Krolestwa Polskiego (Vegetationsbilder aus dem Königreich Polen) 1912. — Szafer, in Kosmos XXXVIII, 1913, p. 1298. — Sukatschew: Entwicklungsgeschichte der Gattung Larix in Lesnoje Djebo 1924 (Ref. in Bot. Centralb. V, 1925, p. 297).

L. europæa, Köppen, Geogr. Verb. Holzgw. europ. Rusl. II, 1889, p. 484—487. — Ascherson & Graebner: Synop. mitteleurop. Fl. 1, I, 1897, p. 203. — Elwes & Henry: Trees, Gr. Brit. and Irel. II, 1907, p 352—353. — Non D. C.

L. sibirica, CZIHAK & SZABO in Flora, 1863, p. 278. — JANKA, in Oestr. Bot. Zeitschr. 1868, p. 665. — KANITZ: Pl. Roman. 1879—81, p. 139. — BRANDZA: Prod. Fl. Roman 1879—83, p. 433. — GRECESCU: Consp. Fl. Roman. 1898, p. 539. — PANTU & PROCOPIANU-PROCOPOVICI, in Bull. Herb. Inst. Bot. Bucarest, 1901, p. 131. — HORNUZAKI, in Oestr. Bot. Zeitschr. LXI, 1911, p. 407. — VIERHAPPER, ibid, 1911, p. 228—231. — ASCHERSON & GRAEBNER: Synop. mitteleurop. Fl. 2'. I, 1913, p. 314. — PRODAN: Fl. Roman. I, 1923, p. 29. — Non Ledeb.

Fig. 24. *Larix decidua* Mill. var. *polonica* (Racib.) Ostf. & Syrach L. Cones of the typical form. Nat. size. (From Szafer 1913).

Outside the area of distribution hitherto treated of, the European Larch appears also in Poland as a special race. KÖPPEN has given a detailed description of its distribution (KÖPPEN: l. c. II, 1889, pp. 484—487), and has also cited some localities where fossil remains are found, north and east of the existing remnants of the primitive larch forests in Poland, thereby proving that the larch enjoyed a wider distribution in prehistoric as well as early historic times than it does at the present day. All these forests of wild larch, however, were classified by KÖPPEN as well as by all other botanists of an earlier date as *L. decidua*, until RACIBORSKI in 1890 showed that the larch from the old Polish stock differed morphologically from the typical European Larch, and bore a close resemblance to *L sibirica*, for which reason he classified it as an independent species, *L. polonica*.

SZAFER in 1913 went closely into the question regarding the justification of its being regarded as an independent species, and gave the first detailed description of its characteristics, at the same time examining it on the spot. The result of his observations convinced him, that the classification was justified, and that its systematic characteristics

gave it a place between *L. decidua* and *L. sibirica.* With regard to its distribution, he showed that the larch in Tatra and Babia góra (West Beskiden) in reality is true *L. decidua*, while on the contrary, the larches found in the wild state on the north-east of this locality in Poland all belong to the Polish Larch. Its intermediate position between the other two European representatives of larch is clearly shown by material from its natural habitat, and from Szafer's analysis of the flowers and cones (Szafer: l. c. Plates I and III). The shape of the cone is strongly reminiscent of a small-coned specimen of *L. decidua*, but the cone-scales are more rounded, resembling those of *L. sibirica*, and less emarginate at the free margins than those of *L. decidua.* The cone is truncate like that of *L. sibirica*, and not so pointed as that of *L. decidua.* The reason for the cones being, as a rule, small, may possibly be, that they are taken from very old trees. It seems to be a fact that the cone of *var. polonica* is smaller than that of either *L. sibirica* or *L. decidua.* Szafer differentiates two types, *f. typica*, and *f. pienina*, the former of which has completely rounded cone-scales, those of the latter having a slight emargination, thus resembling *L. decidua.* He further differentiates between two forms according to the colour of the flowering cone, namely, *f. rubriflora* and *f. viridiflora*, so that both colours can occur here just as in the case of the European Larch: but the green colour, which is the exception with *L. decidua*, is described as common in the case of the Polish Larch.

As far as it is possible to judge from well preserved material and Szafer's detailed treatment, there do not appear, however, to be sufficient grounds for maintaining it as an independent species, as its close resemblance to

Fig. 25. *L. decidua* var. *polonica* (Racib.) Ostf. & Syrach L. A very old tree in Chedmowa Góra reservation in Poland (photo. by W. Szafer).

L. decidua makes it more natural to consider it as a variety of the latter.

L. d. var. polonica is only found in the remains of forests, and then as a rule only in small groves. Most of

the specimens are old individuals, and young trees are not common. The photographs kindly sent by Szafer certainly bear witness to trees of considerable size, but unattractive in shape (Figs. 25 and 26). The first plantations visited by Raciborski are said to have been very beautiful, and Cieslar was

Fig. 26. *L. decidua* var. *polonica* (Racib.) Ostf. & Syrach L. Natural forest, Chedmowa Góra reservation, Poland. (photo. by W. Szafer).

thus induced to suggest a trial with the Polish Larch in forest culture, as he thought it would prove to have the same valuable properties as the larch in the Sudetics (Cieslar l. c. 1914, pp. 182 and 183).

The systematic position of the Polish Larch having been demonstrated, as an intermediate form between the European Larch and the West-Siberian species, a possibility is obtained of being able to explain the systematic position of the larch in its spontaneous occurrences in Rumania, where it has been classified alternately as *L. decidua* and *L. sibirica*, but the question is still incapable of a full explanation.

In Rumania as it is at present, the larch is cited as occurring spontaneously in five different localities; WILLKOMM has mentioned a sixth near Bistritz (l. c. 1887, p. 144), but

Fig. 27. *Larix decidua* var. *polonica* (Racib.) Ostf. & Syrach L. Poland, Chelm at Nowa Slupia. (From Szafer 1913).

this has never subsequently been confirmed, and is therefore not taken into account here. WILLKOMM thought it probable that the European Larch reached its extreme south-easterly limit in the districts round Kronstadt, but CIESLAR did not consider that sufficiently reliable evidence of its occur-

rence east of Tatra had been produced. Our own opinion is that the five localities mentioned here can be relied upon.

As already mentioned (p. 74), the two most southerly localities are those cited by Hayek, and classified as *L. decidua*, namely, the Cibin Mountains and the mountains to the south of Kronstadt, and as we have no material at our disposal regarding these two localities, they must for the present be regarded as *L. decidua*, even though their geographical position renders it probable that they may belong to *L. decidua var. polonica;* the three localities in the north must, in fact, be classified with this variety (see Map VII).

The facts regarding these three localities are as follows: Czihak & Szabo make a reference to *L. sibirica* in Rumania in 1863 (Flora 1863, p. 278), and in 1868 Janka gave a detailed description of his discovery of *L. sibirica* at Ceahlau (Östr. Bot. Zeitschr. 1868, pp. 365, 366). These statements as well as others of still older date (1835 and 1842) are quoted by Kanitz in support of the discovery of *L. sibirica* in Moldavia (Kanitz: Plantas Romaniae, 1879—81, p. 139). Later Rumanian botanists as well as others are agreed that the tree is *L. sibirica* (Brandza, Grecescu, Pantu & Procopianu-Procopovici, Hornuzaki, Vierhapper, and Prodan).

Other botanists have had doubts as to its being *L. sibirica* (Aschs. & Graebn. 1897, and Elwes & Henry, 1907). Ascherson & Graebner, having in their first edition adopted a sceptical attitude, state in the second edition, that they are now satisfied that the tree in question was the true *L. sibirica.*

The light-coloured flowering cones and their pilosity have been specially quoted as being an indication that the tree found at Ceahlau in Moldavia (the most south-easterly

of the three Transylvanian localities where *var. polonica* occurs), and in Bukovina near Krasna-Ilska (the most north-easterly), is *L. sibirica*, but this is insufficient for classifying them as such. Specimens in the Fl. Roman. exsicc. No. 331 b (Kew.; Brit. Mus.; Hort. Bot. Haun.) show that the larch at Ceahlau belongs to the intermediate type between *L. decidua* and *L. sibirica*, and the same is the case with the specimens (No. 331 a) from the Transylvanian district, Turda-Aries, Trascau, 1924. The last-mentioned locality lies a little to the south-west of Klausenberg (the most south-westerly of the three Transylvanian localities for *var. polonica*).

The larches at Ceahlau and near Turda must accordingly be classified as *L. decidua var. polonica*, and the third locality just to the north of them in Bukovina should undoubtedly receive the same classification, while the classification of the two southern localities remains an open question until material comes to hand.

Herb. Mat. examined:

Fl. Roman. exsicc. Nos. 331 a and 331 b (Kew; Brit. Mus.; Hort. Bot. Haun.). — Forest of Maijouv, near Kielce, Poland, 1921, A. Henry (Herb. A. Henry, Dublin).

10. **L. laricina** (Du Roi, *1771*) K. Koch: Dendrol. *1873*, p. 263. —

Britton & Brown: Ill. Fl. U. S. & Canada, I, 1913, p. 60. — Sudworth in Bull. Agric. No. 680, 1918, p. 3. — Sargent: Man. Trees. N. Am. 2'ed. 1921, p. 31. — Rehder: Man. Trees and Shrubs, 1927, p. 52. —

Syn:

Pinus laricina, Du Roi, Observationes Botanicae, 1771, p. XLIX. — Wangenheim: Beytr. Nordam. Holz. 1787, p. 42, cum icon. —

P. Larix Americanæ, Pallas: Fl. Ross. I, 1784, p. 2. Tab. 1, Fig. E. —

P. intermedia, Du Roi: Harbk. Baumz. II, 1800, p. 114. —

Larix americana, Michaux: Fl. Bor. Am. II, 1803, p. 203. — Regel in Gartenfl. XX, 1871, p. 105 et in Act. Hort. Petrop. I, 1871, p. 160. — Sargent: Silv. N. Am. XII, 1898, p. 7, cum icon. —

Pinus microcarpa, Lambert: Genus Pinus, I, 1803, p. 58, cum icon. — Pursh: Fl. Am. Sept. II, 1814, p. 645. —

Larix microcarpa, Desfontaines: Hist. Arb. II, 1809, p. 597 — Carrière: Traît. Conif. 1855, p. 275. — Gordon: Pinetum, 1858, p. 129. —

Pinus pendula, Pursh: Fl. Am. Sept. 1814, II, p. 645. — Hooker: Fl. Bor. Am. II, 1840. — De Candolle: Prodr. 1848. — Non Solander. —

Larix pendula, Macnab, in Quart, Journ. Agric. V, 1834—35, p. 601. — Hooker: Fl. Bor. Am. II, 1840. — Non Salisbury. —

L. intermedia, Lawson & Son, in Agric. Man. 1836, p. 389. —

L. decidua var. americana, Henkel & Hochstetter: Syn. Nadelholzk. 1865, p. 133. —

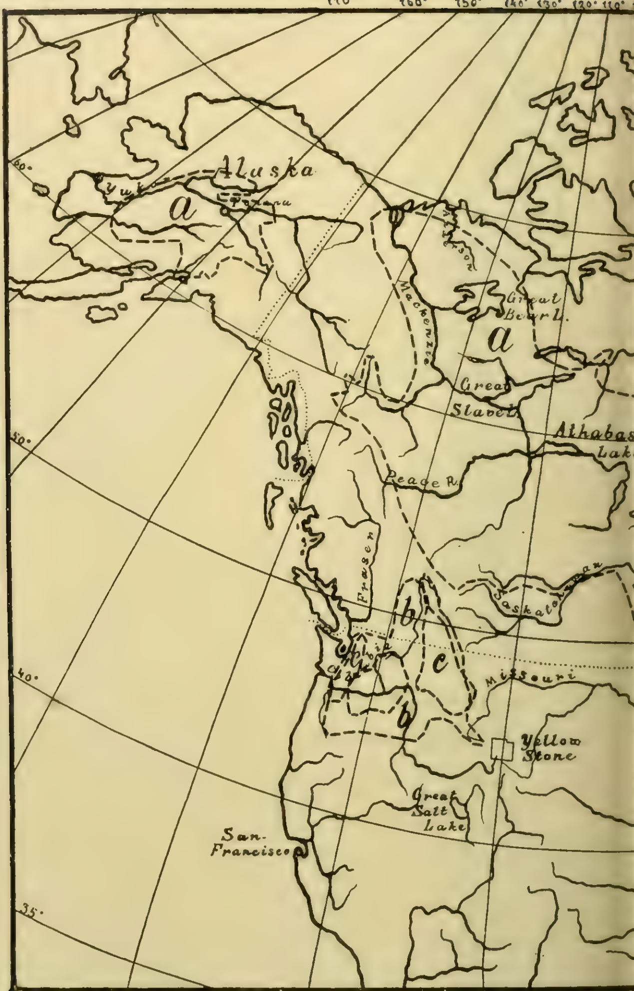
L. alaskensis, W. F. Wight, in Smiths. Misc. Coll. L. 1907, p. 174, Tab. XVII. —

The small-coned American Larch has a very wide area of distribution. The boundary-line extends unbroken from the extreme east of Newfoundland westwards over Canada and the northern U. S. A. to the Rockies, and north-west to the mouth of the Mackenzie River. From this point there is a gap in the line from the water-shed in the northern spur of the Rockies to the interior of Alaska, where it re-appears along the banks of the Yukon River, its tributaries, and lesser streams. The most northerly point is situated at the mouth of the Mackenzie, and a little to the east at the Anderson River; it nearly, buth never quite, reaches lat. 70° N. (see Map VIII). The most southerly localities lie to the south of the Great Lakes, reaching lat. 40° N. south of Lake Michigan, and a trifle more southerly nearer east (about lat. 39° N.). Sudworth's statements regarding its occurrence on the extreme north of the coast of Labrador right up to Baffin Land (U. S. Bull.

Agric. No. 680, 1918, Map 7) are very improbable, and we have been unable to discover any evidence in support of them, either in the shape of other records or specimens from Baffin Land.

Within such wide bounds, it is only natural that the tree should vary somewhat in growth from the good to the poor localities, and from south to north, but it seems otherwise to be a very uniform species, varying but little morphologically. It attains its best development on well-drained ground around the Great Lakes, but here, just as elsewhere within the wide bounds of its occurrence, it is not the dominating tree where the soil is richer and also appeals to other more shadow-enduring species. Most frequently it will be found relegated to low-lying, damp soil, where other trees cannot follow it, and also in the extreme north it becomes the dominating tree. It succeeds in thriving and forming extensive, dense forests even in the very damp areas. In the north it reaches the extreme forest-line together with *Picea mariana*, *P. canadensis*, and other species of trees, or it is found forming the forest-line alone. In the most northerly localities, where it grows together with others, it is the most vigorous species, succeeding in developing as a small tree when other kinds only manage to exist as creeping, stunted individuals. With regard to temperature and humidity, *L. laricina* is capable of growing under very widely differing conditions. HUTCHINSON states its powers of existing with or without water to be three times as great as those of *Alnus incana* (HUTCHINSON, 1918, p. 482).

On marshy ground and in the extreme north, it certainly does not grow as large as in the best localities, but on the marshes in the southern portion of the area it can still



Ma

a. *Larix laricin*

b. ,, *occident*

c. ,, *Lyallii,*

)u Roi), K. Koch
s, Nutt.
·l.

attain a height of 12—15 m. (Sargent: 1918, p. 9), and in Alaska a height of about 10 m. is reached (Kellogg in Forest Serv. Bull. No. 81, 1910). Statements from Minnesota are extant of its attaining a height of 35—40 m. in the districts around the Great Lakes, where, as already stated, it grows best; Henry has there measured a specimen 24,3 m. in height with a girth of about 1,4 m. (Henry & Elwes, II, 1907, p. 393), but as a rule, its extreme height is given as being only 18—20 m. (Sargent: 1921, p. 31; Rehder: 1927, p. 52).

The tree possesses both in its earlier and its later years a pyramidal crown, owing to the shortness of its lateral branches. Branches of the second order are generally pendulous, and contribute towards giving the tree its characteristic appearance. The bark presents a peculiarity in peeling off in small, thin flakes in a manner somewhat similar to that of *Picea abies*. The leaves are green, or a light blueish-green, narrow, and 2,5—3,5 cms. in length. The pronounced keel on the under-side gives them a triangular appearance, seen in transverse section. The young shoots are light-coloured, smooth, or with a slight down, the cones when flowering varying in colour from light red to green.

The mature cone presents the most pronounced characteristic of the species, and varies only to a very slight degree. The cone-scales are thick, bright, smooth, and distinctly arcuate, 12—15 of them together forming the 1,5 cms. long cone. The bracts are $^1/_4$—$^1/_2$ as long as the cone-scales, and vary somewhat in shape, the mucro being either rather shorter or rather longer, and the angle between it and the rest of the free margin of the bract more or less pronounced; the angle is often a distinct right-angle.

On the basis of specimens from Tanana on the Yukon River, WIGHT has distinguished the larch in Alaska as a separate species, *Larix alaskensis* (W. F. WIGHT: A new

Fig. 28. Marsh with *L. laricina* and some *Picea*. Canada, Ont. Holland River near Toronto. Aug 1924. (C. H. Ostf. phot.).

Larch from Alaska. SMITHSON. Misc. Coll. L., 1907, p. 174, Table XVII). Of the characteristics which are said to distinguish it from *L. laricina*, the following are the most important. The bracts are more evenly pointed than in the case of *L. laricina*, where they are described as „more

broad-shouldered" — alluding to the right-angle between the „mucro" and the remaining free margin of the bracts. The cone-scales are fewer in number, longer, and narrower in the case of the Alaskan Larch, and, finally, the shorter

Fig. 29. *L. laricina* (Du Roi) Koch. Cones from Canada, Ontario, Lake Superior (leg. K. Heimbürger, 1928). (Nat. size, upper row dry, lower row wet).

Fig. 30. *L. laricina* (Du Roi) Koch. Cones from cultivated tree; Denmark, Bellevue near Beldringe, Præstø. (Nat. size, upper row dry, lower row wet).

leaves and slower growth are stated to be characteristic for the latter.

An investigation of the material from Fort Gibbon (lat. 65° N., long. 152° W.) which lies on the Yukon River, and is very close to Tanana, from which Wight's type came, confirms Wight's description, and there is no doubt that it fits the larch in Alaska. But this is not sufficient to separate it from *L. laricina*. In a large collection of cones from Lake Superior kindly sent us by Mr. K. Heimbürger 1927, several cones are to be found which exactly correspond to those from Fort Gibbon, and this will probably always be the case whenever there is abundant

material to hand. It must finally be stated, that in the analysis of the cone-scales and bracts of *L. laricina*, as given by BRITTON & BROWN, the bracts have exactly the form described by WIGHT for *L. alaskensis* (BRITTON & BROWN: Ill. Fl. 2nd. Ed. I. 1913, p. 60). Therefore *L. alaskensis*, WIGHT, cannot be maintained, either as a species or variety; it can only be regarded as a form of growth, influenced by inclement external conditions; a similar form will presumably be found further eastwards on the extreme northerly limit for the area of *L. laricina*. We have material from Fort Churchill, Hudson Bay, which supports this supposition.

Fig. 31. *L. laricina* (Du Roi) Koch. Cones of *L. alaskensis* from Fort Gibbon, Alaska. U. S. Nat. Mus. No. 866498. (Nat. size, upper row dry, lower row wet.)

Finally, it should be adduced for the sake of completeness, that HENRY (Gard. Chron. LVIII, 1915, p. 179, Note) wrongly classifies *L. alaskensis*, with *L. Gmelini*, supposing that it does not deviate from the small-coned *L. Gmelini* from Eastern Asia.

Larix laricina is found in a few old Arborets in England, where it has long been cultivated, but has never become common. In Denmark it is stated as planted in the Arboretum at Aalholm in 1832 (WEILBACH: Notes, Bibl. Hort. Bot. Haun.). A tree at Bellevue near Præstø which still exist probably dates from the same time and was in 1924 24,5 m. high with a girth of 1,5 m. (1,3 m. above the ground). The oldest mention of American Larch in forest culture in Denmark from about the year 1800 (OPPERMANN, 1923) we regard as not applying to *L. laricina*, but to

the supposed hybrid, *L. pendula*, our opinion being based upon still-existing specimens from that period. (See below under Hybrids).

Herb. Mat. examined:

In uligin. Am. Sept. (Brit. Mus.). — Labrador: Geol. & Nat. Surv. of Can. No. 24990, Fords Harbour, R. Bell, 1884 (Ottawa Herb.); Anatotak Secound 1928, 364 (Hort. Bot. Haun.). Ungava River, Fort Chino, Spreadborough, 1876 (red coned), (Ottawa Herb.), Ungava Bay, L. M. Turner, 1884 (Gray Herb.); Sandwich Bay, White Bear River, 29. July 1926 (red coned) (Gray Herb.); Fl. of the Labrador Peninsula, Saguenay Co.; Archipel Quapitagone, H. St. John, July 1915 (Ottawa Herb.). — Canada, Miss. Brenton (Kew). — Forêst ou nord du Fort Carlton, Bougeau, 28. Maj 1858 (Kew). — Brouagne, H. St. John, Aug. 1915 (red coned) (O. H.); also colls. from Labrador in U. S. Nat. Herb. — New Foundland: Bay of Islands, North Arm, Fogg, 1926 (Gray Herb.). — Strait of Belle Isle, 1924, Fernald etc. (Gray. Herb.). — In the Gray Herb. 8 other colls. of New Foundland. Colls. also seen in U. S. Nat. Herb. — Flora des Iles St. Pierre et Miguelon (Gray Herb.). Fl. of Newfoundland no. 157, St. Johns, 1894, Robinson & Schrenk (Ottawa Herb.; Kew; Hort. Bot. Haun.). — Fl. of W. Newfoundland, Bay of Island, 1910, Fernald & Wiegand, no. 2408 (Brit. Mus.). — Fl. of Newfoundland, Valley of Exploits River, Grand Falls, 1911, Fernald & Wiegand, no. 4417 (Kew; Hort. Bot. Haun.). — Interior Newfoundland, Ed. Brenton, 1912. (Kew). — Prince Edward Island, Brackley Point, Macoun, June 28, 1887 (Very small coned, the new cones red) (Ottawa Herb.). Magdalen Isles, Fr. Johansen, July 1917 (Ottawa Herb.). — Fl. of Prince Edward Island, Queens County, Brackley, Point Road, 1912, Fernald, Land & John (Ottawa Herb.; Brit. Mus.; Hort. Bot. Haun.). — Fl. of Magdalene Island, Quebec, 1912, Fernald & Wiegand, no. 6716, Grindstone Isl. — (Further Fragm. from N. B. Maine, Mass. Michigan), (Brit. Mus., Gray Herb. and U. S. Nat. Herb.). — New Brunswick, Campbellton, 1876 (Ottawa Herb.). — Gaspé Co., Mt. Albert, Fernald & Collins, July 1906 (red coned), (Ottawa Herb.). — Montmorency Falls, Macoun, June 1915 (red coned) (Ottawa Herb.). — 7 colls. from Quebec (Gray Herb.). — Quebec, Flamand, leg. K. Heimbürger, 1926, C. H. Ostenfeld: Canadian Plants, no. 626 (Hort. Bot. Haun.). — Ontario: 3 colls. in Ottawa Herb. — Massachusetts, 1 coll. (Gray Herb.). — Rhode Island: 1 coll. (Gray. Herb.). — Newport, Nova Scotia, June 18, 1918, J. G. Jack. (Arn. Arb.). — Arctic Canada, Churchill, Hudson Bay 16-7-1923., Hort. Bot. Haun.; Birket Smith (5. Thule Expedition 1921—24, red cones). — St. Thomas, Ontario, 1906, Geo. L. Fischer (Arn. Arb.). — Churchill, Hudson Bay, 1910. J. M. Macoun (red coned, rather few scales in the cone). (Ottawa Herb.). — Manitoba, Near Branden, Macoun, 1896

(very small coned). (Ottawa Herb.). — Ohio: 1 coll. (Gray Herb.). — Buffalo, G. W. Clinton (Brit. Mus.). — Maine, Dr. A. Gray, 1877 (Kew). — Maine, J. Blake (Brit. Mus.). — Brownville, Maine, Aug. 29, 1895, J. G. Jack (Arn. Arb.). — New Hampshire, 5 colls. in Arn. Arb. at Gray Herb. — Adirondacks Mt. New York, T. S. Brandegee, 1884, Ex. Herb. Univ. Calif. (Hort. Bot. Haun.). 1 other coll. of New York (Gray Herb.). — Near Port Huron, St. Claire Co. Michigan, C. K. Dodge, October 11, 1891 (Arn. Arb.). — North of College, Agricultural College, Michigan, 1898 (Arn. Arb.). — Roadside near Douglas Lake, Cheboygan Co., Michigan, J. H. Ehlers, July, 7, 1917. (Arn. Arb.). — Michigan, 3 colls. one red coned (Gray Herb.); also in U. S. Nat. Herb. — Wisconsin: 3. colls. (Gray Herb.). — Illinois (Gray Herb.). — Maryland, Pennsylvania, New Jersey and Indiana (U. S. Nat. Herb.). — Saskatchewan, North of Prince Albert, Macoun, 1896 (small coned) (Ottawa Herb.). — N. W. Ter., Lat. 61° Long. 104°, Tyrell, 1893 (Ottawa Herb.). — Lake Huron, Dr. Todd (Kew.). — Winnipeg Lake, 1884, Jas. M. Macoun (Ottawa Herb.; Brit. Mus.). — Lake Superior, Heimbürger 1928 (Hort. Bot. Haun.). — Heron Bay, C. H. Ostenfeld, 1924 (Hort. Bot. Haun.). — Charlotte, Vermont, 1877, C. G. Pringle (Kew). — Mac. Cubbins Lake, Minnesota, E. P. Sheldon, May, 1895. Ex. Herb. Univ. Calif. (Hort. Bot. Haun.). — Swamps at Mineral Springs 1913, Ove Paulsen (Hort. Bot. Haun.). Dease River, Northern Brit. Col., Dawson, 1887 (Brit. Mus.; Ottawa Herb.). — Kokomo Creek, 40 ml. north of Fairbanks, Alaska, L. M. Pringle, Aug. 17, 1909. (U. S. Nat. Herb. et ex U. S. Nat. Herb. in Hort. Bot. Haun.). — Fort Gibbon Alaska, A. G. Maddrew, Ex. Herb. U. S. Nat. Herb. (Hort. Bot. Haun.). — Fort Gibbon along the Yukon River, A. S. Hitchcock, 1909 (U. S. Nat. Herb.). — E. Koehne: Herb. dendrologicum (Hort. Bot. Haun.).

IV. Hybrids.

There are three areas where two different species of larch meet in nature. In two cases, those of *L. Potanini—L. Mastersiana*, and *L. occidentalis—L. Lyallii*, the species are so little known and so closely related, that it has hitherto been impossible to distinguish hybrids between them. In the third case, however, where the question is one of two widely differing species, *L. sibirica—L. Gmelini*, it is evident that hybrids are produced in the areas where their respective boundaries meet.

Hybridisation has undoubtedly taken place several times under cultivation, when two or more species have been brought together, and it is probable that a considerable number of crossings might be made artificially, but deliberate experiments of this nature have not been mentioned hitherto in the literature extant upon the subject.

L. Gmelini × sibirica, Szafer in Kosmos, XXXVIII, *1913*, p. 1297.

Syn:

L. Czekanowskii, Szafer l. c.

This hybrid is probably found on a broad belt stretching from Lake Baikal northwards to about the mouth of the Jenisej. It has been described by Szafer, and investigated by Sukatschew in 1928 in the district round Lake Baikal, where it seems to grow extensively. He has kindly sent us abundant specimens of cones taken from a large number of trees, and these specimens give evidence of many different intermediate stages between the supposed parent species (see figs. 32—33 showing some of the cones).

Middendorff (Middf. Reise IV, I, Teil, pp. 530 and 595) and Cajander (Act. Soc. Sci. Fennicae. XXXII, No. 3, 1904, p. 8) have both previously stated that no well-defined difference existed between the two species, and this belt with its hybridogenous intermediary forms is the natural explanation of their assertions. The matter has been dealt with in greater detail under *L. Gmelini.*

Herb. Mat. examined:

Maretuj, Cape Ulan (3 samples); the village Listwenicznoja, and the bays Kurkut (5 samles), Koty (3 samples) and Krestowka (1 sample), — altogether 14 samples from 14 different trees, all from the western side of the Lake Baikal, W. Sukatschew, 1928 (Hort. Bot. Haun.). —

L. decidua × laricina, A. Henry, in Gard. Chron. Ser. 3. LVIII, *1915*, p. 178.

REHDER: Man. Trees and Shrubs, 1927, p. 52. —

Syn:

Pinus pendula, SOLANDER, in Aiton: Hort. Kew. III, 1789, p. 369. — Non Pursh. —

Larix pendula, SALISBURY, in Trans. Linn. Soc. VIII, 1807, p. 314. — Non McNab. —

L. dahurica, ELWES & HENRY: Trees, Gr. Brit. and Irel. II. 1907, p. 379—382, pro parte. Non Turcz. (Conf. HENRY, in Gard. Chron. Ser. 3. LVIII, 1915, p. 178, Note). —

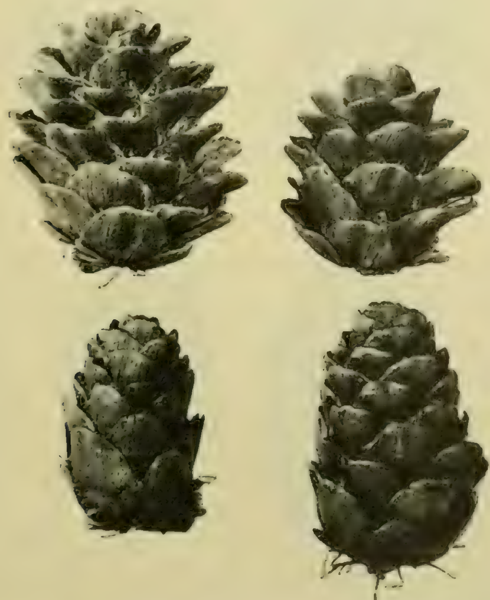


Fig. 32. *L. Gmelini* × *sibirica*. Kurkut on the west side of Lake Baikal. (Leg. Sukatschew, 1928). (Nat. size, upper row dry, lower row wet).

L. americana, forma, OPPERMANN, in Det forstl. Forsøgsv. VII, 1935. p. 190 and 278. (Cum icon.). — Non Michaux.

There has been a good deal of uncertainty with regard to the origin of this Larch. From the time when it was first described as *L. pendula* (1789) until 1915, it was always regarded as indigenous to North America, where the statements regarding it were certainly very diverse and

usually of a very summary character, usually based only on the accounts of others.

Of the many statements regarding its occurrence in North America, there are only two authors who could

Fig. 33. *L. Gmelini* × *sibirica*. Kurkut on the west side of Lake Baikal, (leg. Sukatschew, 1928). (Nat. size, upper row dry, lower row wet).

have based their records on personal observations. The one Macnab (in the Quart. Journ. Agric. V, 1834—35, pp. 594—605), simply mentions one species of larch (*Larix pendula*) observed by him in the neighbourhood of Lake Ontario, and his description coincides entirely with *L. laricina*, thus being of no value as regards the present question. The other description, which strikes one as more convincing, is given by Pursh (Flora Americae Septentrionalis, II, 1814,

p. 645). According to the title-page, he relies upon "twelve years travels and residence in that country", and, describing *L. pendula*, Lambert, and *L. microcarpa*, Lambert, jointly, he says positively that Michaux is mistaken in including them under one species, adding: "I never saw them both growing in the same place, or even near one another." We have, nevertheless, no doubt at all, that this is wrong, and that his remark considers only *L. laricina*, the occurrence of which in two forms is due in the main to the different characters of the growth localities. The description of the two "species", as far as it concerns their habitats, sounds extremely improbable. *L. pendula* is said to be "a beautiful tree, resembling the European Larch"; and grows "in low cedar swamps", while *L. microcarpa*, which certainly "resembles the preceding *L. pendula*" has its home "on high mountains". Finally, *L. pendula* — which must, at any rate have been less common than the other, as no subsequent attempts to find it in North America have been successful — has been provided with American popular names (Tamarack, Hackmatack), no American name being given to *L. microcarpa (laricina)*, which otherwise is known under these names. As already mentioned, we have no doubt that there is only one species of larch of that group in North America, and that Pursh's description is clearly influenced by Lambert's account (in Genus Pinus, 1803), in which two "species" are mentioned, but which, in part at all events, is based upon material from specimens cultivated in England.

In Solander's Notes (Brit. Mus., unpublished), its habitat is given as follows: — „Habitat in New Foundland insula Amer. septentr. Latitud. 48 gr. ubi hiems perquam aspera", but in Solander's description in Aiton: Hort. Kew., there

only stands "Nat. of North America. — cult. 1739 by Peter Collinson". Thus it appears from the oldest descriptions that the tree was to be found in Newfoundland as well as in culture. Fernald in 1915 answered an enquiry from the British Museum with regard to *L. pendula* in Newfoundland, by sending herbarium specimens (Herb. Brit. Mus.) from various localities on the island, but all of them distinctly belong to *L. laricina*, and he knows only one species.

The tree as cultivated in England (Collinson, Mill Hill), which has been described as *Pinus pendula*, is positively stated as having come from America. We do not, however, think that any proof exists of its having been found in North America in the wild state.

Morphologically, it occupies an intermediate position between *L. decidua*, and *L. laricina*. The type specimen in the British Museum gives the length of a cone as 25 mm., and two still immature cones are 23 mm. and 19 mm. respectively. The immature cones are distinctly reddish-mauve, and in this point they resemble *L. decidua*. The lowest cone-scales are larger than those of *L. decidua*, and in this point they show a decided approach to the type of *L. laricina*, as well as in the fact of the cone-scales being thicker and brighter than those of the European Larch. Lambert reproduces material from Collinson's tree at Mill Hill (Genus Pinus, 1803, Pl. 36).

On account of its intermediate position between the European Larch and the American Larch and also of the fact that it is found in culture, we agree with Henry's explanation, wherein he describes it as a hybrid, produced in cultivation, between *L. decidua* and *L. laricina* (Gard. Chron. LVIII, 1915, p. 178).

A. Oppermann has shown, that a group of peculiar-looking larches about 125 years old is to be found in Denmark (Folehave), and he classifies them as "a kind of *L. americana* which has larger cones than the pronounced *L. microcarpa*" (A. Oppermann: Cultivation of Larch in Denmark, 1923, p. 319). We regard them as being *L. pendula*,

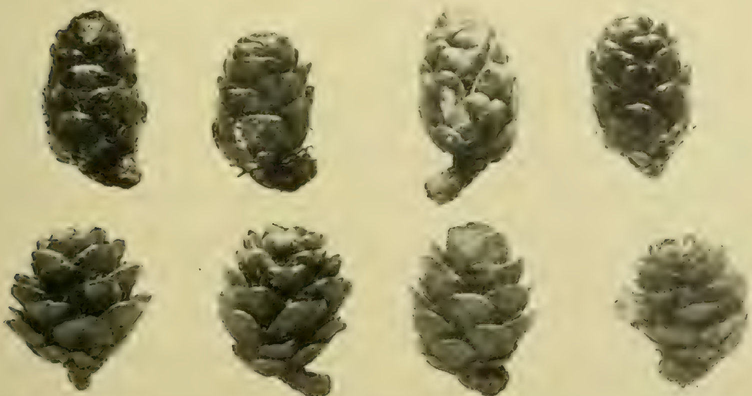


Fig. 34. *L. decidua* × *laricina* ? *(L. „pendula").* Cultivated, Denmark Folehave, 1922. (3/4 nat size, upper row wet, lower row dry.)

viz., hybrids between *L. decidua* and *L. laricina*, but have to add, that it is extremely difficult to decide whether such trees, which are found in culture among many forms of *L. decidua*, really are *L. pendula*, it being possible to find among *L. decidua* specimens of great similarity, but it is at least evident that the said specimens are not *L. laricina*.

Herb. Mat. examined:

Culta; Solander, Type specimens, no locality, no year (Brit. Mus.) — Woburn Abbey, Bedfordsh., England, Oct. 1928, C. Syrach Larsen (Hort. Bot. Haun.). — ? Denmark, Folehave on Sjælland (1922).

L. Kaempferi × decidua, Coaz, in Schw. Zeitschr. Forstw. LXVIII, *1917*, p. 12.

L. leptolepis × *decidua*, Henry, in Irish Times, June 24, 1919. — Henry & Flood, in Proc. Roy. Irish Acad. XXXV, B, 1919, p. 55. — Rehder, in Journ. Arn. Arb. I. 1919, p. 52. — Dallimore & Jackson: Handb. Conif. 1923, p. 280. — Rehder: Man. Trees and Shrubs. 1927, p. 51. —

Syn:

L. Marschlinsi, Coaz: l. c. 1917.

L. eurolepis, Henry: l. c. 1919. — Henry & Flood: l. c. 1919. — Dallimore & Jackson: l. c. 1925. — Rehder: l. c. 1927. —

L. Henryana, Rehder: l. c. 1919. —

Coaz can only be understood to mean, that he believes he has observed the cross *L. Kaempferi* × *decidua;* but others are of the opinion that it is *L. Kaempferi* × *sibirica* (Henry & Flood: l. c. p. 57; vide Henry's notes: ibid. p. 66; Dallimore & Jackson: l. c. p. 292). Coaz's observations are based upon specimens of seed from a *L. Kaempferi* in the neighbourhood of Morat in Switzerland. *L. decidua* and *L. sibirica* were both found close by, but, as already stated, Coaz believes the European Larch to be the male parent in the supposed cross; it seems, nevertheless, as though there might be some doubt as to whether it was the one or the other. If, however, any regard is to be paid to his observations, it can only be in the present shape; perhaps it would be best to neglect them entirely.

The oldest specimens of the hybrid *L. Kaempferi* × *decidua* recognised with certainty originated about 1900 upon the estates of Dunkeld and Murthly in Perthshire, Scotland, and the first detailed report by Henry & Flood in 1919 was based upon material derived from this source.

It is an easily recognisable form, intermediate between the two widely different parent trees. The cone is more cylindrical than that of *L. Kaempferi*, the cone-scales being at the same time less recurved. The one-year shoots are

something between the reddish-brown, stout shoots of the Japanese Larch, and the light-coloured, slender shoots of the European species.

In the seed-bed, one-year plants of *L. Kaempferi* are distinguishable by being considerably smaller than those of *L. decidua*, and in this particular too the one-year hybrid plants occupy an intermediate position.

From the forestry point of view, the European Larch has a better shape, but is, upon the other hand, extremely susceptible to the attacks of *Dasycypha Willkommii*, which the Japanese Larch is not. The hybrid combines the good shape of the one and the powers of resistance against canker of the other, and is therefore now the subject for larger experiments in forests. The second and third hybrid generation has also been raised, and is now being experimented with.

In Denmark, one specimen is known from Dr. Børgesen's garden at Hellebæk, and young plants of *L. Kaempferi* from various Danish forests show signs of being hybrids with *L. decidua*.

Herb. Mat. examined:

Buffalo Park, Murthly, Scotland, 1923, J. M. Murray (2 samples). — Scotland, 1923, J. M. Murray. — Dunkeld, Scotland, September 1926, C. Syrach Larsen. — Denmark, the Garden of Dr. Børgesen at Hellebæk 1925, C. H. Ostenfeld. — Denmark, Strødam, near Hillerød (specimens sent from Scotland).

The reciprocal cross, *Larix decidua × Kaempferi*, has been observed in the Frijsenborg Forest District, where the first hybrid generation was planted as one-year plants in 1925. The seed was collected from a 90—100-year-old *L. decidua* in »Frijsenborg Lystskov«, where the Japanese Larch stands a little to the west and south-west of the former. The seed yielded only a minimum of hybrids, the

Fig. 35. *L. "pendula"* Soland. Cultivated trees about 125 years old, from Folehave, Denmark. From A. Oppermann Forstl. Forsøgsvæsen 1923.

majority of plants being pure *L. decidua*. This seems to indicate that crossing *L. decidua* × *Kaempferi* is attended with more difficulty than the reverse hybridisation.

V. Summary.

1. In the present paper the areas of distribution of the various species of larch are dealt with in detail, but only as far as the distribution concerns the wild-growing plants; the cultivation of the larches, which in many regions is of rather considerable economic interest, has mostly been omitted.
2. The authors recognise 10 species of larch and three geographical varieties. According to the international rules of nomenclature, the following names are valid: *L. Griffithiana*, *L. Mastersiana*, *L. Potanini*, *L. occidentalis*, and *L. Lyallii*, which five species constitute a natural sub-genus, characterised by the bracts of the cone being longer than, and reaching out of, the cone scales. All these species have restricted areas of distribution, being mountain trees from the great mountain regions of western N. America and south-eastern Asia respectively. Of these, only *L. occidentalis* has any considerable economic value, but none of them have hitherto been taken into culture on a large scale.
3. The five other species are *L. Kaempferi* (*L. leptolepis*) *L. Gmelini* (*L. dahurica*) with the varieties *olgensis* and *Principis Rupprechtii*, *L. sibirica*, *L. decidua* (*L. europaea*) and *L. laricina* (*L. americana*). Of these, *L. Kaempferi* has a small area of occurrence on Hondo, Japan, while *L. decidua* has a medium-sized area. *L. Gmelini*, *L. sibirica*, and *L. laricina*, on the other hand, have very large areas, the last inhabiting the northern temperate and sub-arctic zones of N. America from Newfoundland to Alaska. *L. Gmelini* and *L. sibirica* divide Eurasia between them, *L. Gmelini* being found in Eastern Asia, and as

far west as from Lake Baikal northwards; *L. sibirica* in the area west of *L. Gmelini* as far west as N. E. Europe.

4. The differences between the species and their variability have been considered under each species, and their synonymy and the records of specimens upon which our conclusions are based are cited in full. The geographical varieties of *L. Gmelini,* namely *L. olgensis* and *L. Principis Rupprechtii,* form a kind of transition to the first-named sub-genus, and their areas of occurrence also cause them to approach the Chinese species of that sub-genus.
5. The variety of *L. decidua, var. polonica,* is a link between that species and *L. sibirica,* and is a form which appears to be not far from extinction.
6. The species of the second sub-genus are of importance as forest trees, and several of them are objects of extensive cultivation.
7. Between the species which meet in nature, hybrids are found as regards the combination *L. Gmelini* × *sibirica,* while the combinations *L. Lyallii* × *occidentalis* and *L. Mastersiana* × *Potanini* have not yet been recognised. When cultivation brings two species together, hybrids also arise. *L. decidua* × *laricina* has been known for a very long time, but is usually misinterpreted; *L. Kaempferi* × *decidua* is much more recent, but seems to be of economic value, and will probably become much commoner; *L. Kaempferi* × *sibirica* has been reported, but is not definite.
8. When *L. Gmelini* becomes more used in cultivation, this most valuable species will no doubt hybridise with several of the other species.

CONTENTS

Forelagt paa Mødet den 3. Maj 1929.
Færdig fra Trykkeriet den 30. Juni 1930.

BIOLOGISKE MEDDELELSER

UDGIVNE AF

DET KGL. DANSKE VIDENSKABERNES SELSKAB

6. BIND (Kr. 18,10):

Kr. Ø.

1. Lundblad, O.: Zur Kenntnis der Quellenhydracarinen auf Møens Klint nebst einigen Bemerkungen über die Hydracarinen der dortigen stehenden Gewässer. Mit 7 Tafeln und 5 Textfiguren. 1926 .... 5.00
2. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. II. Phæophyceæ. 1926 .. 6.00
3. Ostenfeld, C. H.: The Flora of Greenland and its Origin. 1926 .... 3.35
4. Fibiger, Johannes and Møller, Poul: Investigations upon Immunisation against Metastasis Formation in Experimental Cancer. With 5 plates. 1927 .... 2.75
5. Lind, J.: The Geographical Distribution of some Arctic Micromycetes. 1927 .... 1.50
6. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part 1. Bangiales and Nemalionales. 1927 .... 4.50
7. Lindhard, J.: Nogle Undersøgelser over den respiratoriske Kvotient under kortvarigt Muskelarbejde. 1927 .... 1.00

7. BIND (Kr. 14,85):

1. Raunkiær, C.: Dominansareal, Artstæthed og Formationsdominanter. 1928 .... 1.75
2. Petersen, C. G. Joh.: On some Biological Principles. 1928 ... 2.00
3. Vimtrup, Bj.: Undersøgelser over Antal, Form, Bygning og Overflade af Glomeruli i Nyren hos Mennesker og nogle Pattedyr. 1928 .... 1.30
4. Bensley R. R. og Vimtrup, Bj.: Undersøgelser over de Rouget'ske Cellers Funktion og Struktur. En Metode til elektiv Farvning af Myofibriller. 1928 .... 1.00
5. Thomsen, Oluf: Die Erblichkeit der vier Blutgruppen des Menschen, beleuchtet durch 275 Nachkommenschaftsindividuen in 100 AB (IV)-Ehen (nebst 78 Kindern, von denen nur der eine (AB)-Elter bekannt ist). 1928 .... 1.00
6. Krogh, A. and Hemmingsen, A. M.: The Assay of Insulin on Rabbits and Mice. 1928 .... 0.70
7. Johnsson, J. W. S.: L'Anatomie mandchoue et les Figures de Th. Bartholin, étude d'iconographie comparée. 1928 .... 2.00
8. Kemp, Tage: Om Kromosomernes Forhold i Menneskets somatiske Celler. 1929 .... 1.75
9. Weis, Fr.: Fysiske og kemiske Undersøgelser over danske Hedejorder. Med særligt Henblik paa deres Indhold af Kolloider og Kvælstof. With a Resumé in English. 1929 .... 8.25

Kr. Ø.

8. BIND (Kr. 14,95):

1. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part II. Cryptonemiales, Gigartinales and Rhodymeniales. Les Mélobésiées par M^{me} Paul Lemoine. Avec 4 planches. 1929 .... 4.50
2. Thomsen, Oluf og Kettel, Karsten: De menneskelige Isoagglutininers og tilsvarende Blodlegemereceptorers Styrke i forskellige Levealdre. Med 1 Tavle. 1929 .... 1.60
3. Krabbe, Knud H.: Recherches sur l'existence d'un œil pariétal rudimentaire (le corpuscule pariétal) chez les mammifères. Avec 11 planches (22 figures). 1929 .... 2.80
4. Rosenvinge, L. Kolderup: Phyllophora Brodiæi and Actinococcus subcutaneus. With one plate. 1929 .... 2.40
5. Thomsen, Oluf og Kettel, Karsten: Kvantitative Undersøgelser over de menneskelige Isoagglutininer Anti-*A* og Anti-*B*. 1929 .... 0.65
6. Madsen, Th. et Schmidt, S.: Toxine et antitoxine diphtériques. 1930 .... 2.00
7. Lundblad, O.: Die Hydracarinen der Insel Bornholm. Mit 9 Tafeln und 1 Textfigur. 1930 .... 5.00
8. Lindhard, J. and Möller, Jens P.: On the Origin of the Initial Heat in Muscular Contraction. 1930 .... 1.00

9. BIND (under Pressen):

1. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part III. Ceramiales. 1930 .... 7.50
2. Ostenfeld, C. H. and Syrach Larsen, C.: The species of the Genus Larix and their geographical distribution. With 35 illustrations and 8 maps. 1930 .... 5.00

STRAY CONTRIBUTIONS TO THE FLORA OF GREENLAND I-V

BY

MORTEN P. PORSILD

(WITH 8 FIGURES IN THE TEXT)

ARBEJDER FRA
DEN DANSKE ARKTISKE STATION PAA DISKO Nr. 13

SÆRTRYK AF MEDDELELSER OM GRØNLAND LXXVII

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI A/S
1930

Arbejder fra den Botaniske Have i København. Nr.

BOTANISK HAVES BIBLIOTHEK
GOTHERSGADE 130
KØBENHAVN (COPENHAGEN)
DANMARK

The Botanical Library of the University of Copenhagen takes pleasure in sending you the following Arbejder fra den botaniske Have i København, nos 116, 117, 118.

containing the results of work done at the Botanical Garden and reprinted from Danish scientific journals.

The Botanical Library will be glad to receive copies of publications from your Department in exchange.

Arbejder fra den Botaniske Have i København.

Arbejder fra d

Distributed from the Botanical

Regarding the no
danske Botaniske Litteratu
botaniske Have i København

1912	70.	Andr.Lundager:	Some Germ
1913	71.	J. Lind:	Dani of E
-	72.	Carl Christensen:	Den
-	73.	Eug.Warming:	Obser l'ov

Distributed from the Botanical Library of the University in Copenhagen.

Regarding the nos. 1 to 69, cfr. C.Christensen: Den danske Botaniske Litteratur 1880-1911, p.XX-XXI (Arbejder fra den Botaniske Have i København, Nr.72).

1912 70. Andr.Lundager: Some Notes concerning the Vegetation of Germania Land. North-east Greenland.

1913 71. J. Lind: Danish Fungi as represented in the Herbarium of E.Rostrup.

\- 72. Carl Christensen: Den danske botaniske Litteratur 1880-1911.

\- 73. Eug.Warming: Observations sur la Valeur systématique de l'Ovule.

1914 74. F.Børgesen: The Species of Sargassum.

\- 75. C.Raunkiær: Sur la végétation des alluvions méditerranéennes françaises.

\- 76. Knud Jessen: The Structure and Biology of arctic Flowering Plants II.1. Rosaceae.

\- 77. Carsten Olsen: do do do II.2. Cornaceae.

\- 78. C.H.Ostenfeld: Plants collected during the first Thule Expedition to northwest Greenland.

\- 79. C.Hagerup: The Structure and Biology of arctic Flowering Plants II.3. Caprifoliaceae.

1915 80. Fr.J.Mathiesen: do do do II.4. Primulaceae

1916 81. [illegible]: Om Spalteaabningerne hos Griselinia littoralis Raoul og Campanula vidali Wat .

1917. 82. [illegible]: Planteanatomiske Bidrag.

1918 83. [illegible]: Planteanatomiske Bidrag II.

\- 84. [illegible] Petersen: Om Synura Uvella Stein og nogle andre Chrysomonadiner.

\- 85. F.Børgesen & C.Raunkiær: Mosses and Lichens collected in the former Danish West Indies.

\- 86. Ernst Østrup: Fresh-Water Diatoms from Iceland.

1920 87. Fr.Kränzlin: Orchidaceae quaedam Americanae.

\- 88. C.H.Ostenfeld: A List of Arctic Caryophyllaceae.

\- 89. Eug.Warming: The Structure and Biology of Arctic Flowering Plants. Caryophyllaceae

1912 90. Ove Paulsen: Studies on the vegetation of the Transcaspian Lowlands.

[illegible] 91. Ove Paulsen: Studies in the vegetation of Pamir.

[illegible] 92. [illegible]: The Lichen Flora and Lichen vegetation of Iceland.

[illegible] 93. [illegible] Lange: Botaniske Haver.

STRAY CONTRIBUTIONS TO THE FLORA OF GREENLAND I-V

BY

MORTEN P. PORSILD

(WITH 8 FIGURES IN THE TEXT)

ARBEJDER FRA
DEN DANSKE ARKTISKE STATION PAA DISKO Nr. 13

SÆRTRYK AF MEDDELELSER OM GRØNLAND LXXVII

KØBENHAVN
BIANCO LUNOS BOGTRYKKERI A/S
1930

Arbejder fra den Botaniske Have i København. Nr. 118

CONTENTS

INTRODUCTION

Ask a person who has lived many years in the Arctic and become acclimatized to it, what, if anything, he finds wanting of the ordinary life of his more genial mother country, he will respond that he misses something, sometimes so much that he is heartsick with longing, such things as fresh strawberries, the shade of trees, or good music. For the last, quite lately radio has been a good substitute, but the other things will probably for all time be unattainable.

It had been the writer's wish for many years to make a trip to southernmost Greenland, that peculiar section, part of a big Arctic land, but not Arctic itself, or rather, with the Arctic keynote modified by a nuance of something more genial. It is a country where trees still are seen; where Eric the Red and his people had their farms, churches and cloisters; and where now their Eskimo victors, their seals having gone, are trying to establish a living by cattle- and sheep-ranching, in the fashion of the old Norse and on their very farm-sites. But the short Arctic summer too often made such a trip impossible. The fact that all connection with the outer world is limited to three months, condenses to the same short period all administrative and clerical work. Also, the steamers do not touch the ports of the whole coast, and even if such a rare event should happen, one would be without means of transportation in the working field if they were not taken along from the starting point.

In 1924, the Danish Government had granted the Arctic Station a new motor-boat, the "A. Holck", named in memory of the man through whose generosity the Danish Arctic station was founded in 1906. Built as a yawl of 15 tons burden, with a 12 H. P. engine, it was stronger and more sea-worthy than that which the station had previously possessed. It arrived in the autumn, too late for an extended experimental cruise that year, but during the winter the southern trip was prepared for. As the ships in the spring of the next year brought no visitors to the station, there seemed to be no obstacle, and the long desired trip was started.

With the writer was his son Mr. A. E. PORSILD as "second in command" on deck or in the engine-room, as circumstances would require, and as botanical assistant in the field. In addition there were two Eskimo hunters, the writer's usual companions on boat trips, and lastly, Master OVE STEN PORSILD, the writer's youngest son, who acted in the capacity of "odd-job-boy". We started from Godhavn on July 6th in the afternoon, went, watch by watch, to Sukkertoppen and Frederikshaab, reaching Ivigtût the morning of July 12th. Having visited the cryolite mine, we explored the fertile Björnedal the next day, and continued to "Nyboes Canal", in which the boat was trapped, until the next tide mercifully released it; we then proceeded to Julianehaab, arriving on July the 16th. Leaving the next day, we had two very unpleasant days across Julianehaab Bay, where we were forced to encounter fog, heavy sea, drifting ice and the danger of rocks all at once, until we reached Nanortalik on July 19th. From there we went through the picturesque sounds of Torssukátaq and Prins Christians Sund, stopping, because of darkness, at Igdlorsuit and arriving at our farthest point, Nunatsuk on the east coast, on July 21st. From here we rounded the theatrical Walkendorf Islands, explored the fiords around Ilua, and went over Frederiksdal to Nanortalik on July 25th. The next days were spent in the Tasermiut Fiord and on July 28th we left Nanortalik and went to Agdluitsoq Fiord. Having finished there, we passed along Lichtenau and Sydpröven to Julianehaab on Aug. 1st. After having prepared and dried our collections, we set out, on Aug. 4th, for the Qaqortoq and Igaliko Fiords, and on Aug. 11th we sailed on our way out of Brede Fiord and Torssukátaq. When we came out, on the 12th, a strong southerly gale with ugly eddy-squalls met us and forced us farther out from the coast, until, after a watch of 12 hours, we found shelter at Tigssaluk. Though the next day was foggy, we came to Neria, Narssalik and Frederikshaab, and continued on the 15th, still with fog, to Avigait, where we stayed for the night. The next day being better, we continued homeward and reached Godthaab, the capital of Greenland, on Aug. 17th. A few hours later the s. s. "Hans Egede" came from Denmark and in it Mr. HAUGE, Minister of the Interior and as such, the highest official of Greenland, and with him Mr. DAUGAARD-JENSEN, Director of the Administration of Greenland. As an inspection of the Danish Arctic Station was in their program, the rest of our trip was a race with the s. s. "Hans Egede", with too long watches, until we reached our home on Aug. 22nd.

On this maiden-trip of 48 days the "A. Holck" had been running one-third of the time, as shown by the exact figures of her log-book, and had covered over 2000 miles. She had experienced nearly all the features and surprises an Arctic coast can give, and proved herself

a very sturdy and reliable boat, giving her crew safe transportation under all conditions, and cosy quarters and working room when anchored.

The southernmost region, especially the district of Julianehaab 60°—61° N., is one of the best botanically explored sections of Greenland. We owe our knowledge of the flora to a long line of well-trained experts: M. Wormskjold, 1813; F. C. Raben, 1823; J. Vahl, 1828—30; A. Berlin, 1883; P. Eberlin, 1883—85; Th. Holm, 1886, (Frederikshaab district only); L. K. Rosenvinge, 1888; N. Hartz, 1889; and to a still larger number of skilful amateurs, geologists and surveyors or officials residing in the country, among whom may be mentioned: A. Kornerup, C. Petersen, P. L. P. Sylow, N. O. Holst, L. Schiødte, A. Jessen, and Mrs. Eleonora Lundholm. All results so far are, for the flora of the vascular plants, incorporated in L. K. Rosenvinge's "Andet Tillæg til Grønlands Fanerogamer og Karsporeplanter", Medd. om Grl. III. Forts. III. 1892, in which paper, besides additional localities for other sections of Greenland, there is the best list of plants occurring in the southern part. The same author has published an elaborate study on the geographical and ecological conditions of the flora: "Det sydligste Grønlands Vegetation", (with a resumé in French), Medd. om Grl. 15., 1898. Since the issue of these two important papers, large collections have been made by Dr. J. Lindhard (Ivigtût-district) and by Dr. H. Deichmann, and especially by Dr. G. Meldorf (Julianehaab-district), which are deposited in the herbarium of the Botanical Museum at Copenhagen, but which have not been published.

There was thus no great probability that new researches would yield results worth the expenses nor had we any ambition in that direction. Our aim was simply

"these wonders to behold"

and to obtain research material for comparison with plants from other sections. And when, nevertheless, we can add some additional localities for some of the rarest species, it only shows how difficult it is to obtain a complete knowledge of the flora of so vast a country as Greenland.

Here follows a list of the localities visited by us, and their geographical latitude.

Frederikshaab district.

Frederikshaab, 62°5'.
Eqaluit in Kuanersôq, 62°5'. Thickets of Salix and Betula.

Narssalik Island, 61°38′.

Neria Island, 61°35′ (collections by J. EUGENIUS).

Ivigtût, 61°13′. Thickets and fertile slopes.

Björnedal, 61°15′. Sea shore, dry grass-fields, thickets of Salix, Betula, Alnus, Sorbus.

Julianehaab district, northern part.

Julianehaab, 60°43′, around the colony.

Qagssiarssuk in Tunugdliarfik Fiord (Eric the Red's estate "Brattahlið", 61°10′. Sea shore, grass-fields.

Kiagtût, i. e., somewhat south of that place, opposite the former locality, 61°10′. Dry alluvial ground, water courses, bogs, thickets.

Narssaq at Tunugdliarfik Fiord, 60°55′, near the village.

Qaqortoq, near the Norse church ruin, 60°49′, grass-fields.

Tasiússaq, in Qaqortoq Fiord, 60°50′. Heaths and bogs, thickets and fertile slopes.

Igaliko (the ancient Norse episcopal seat "Gardar"), 60°59′. Dry and barren fields, overgrazed meadows.

Qagssiarssuk, Igaliko fiord, 60°53′. Sea-shore, dry Dryas- and Cladonia-heath, ponds in thickets, brooks.

Eqaluit, Igaliko fiord, 60°47′. Thickets, bogs and ponds.

Sydpröven, 60°26′ and Lichtenau, 60°30′, around the villages.

Amitsuarssuk, at the head of one of the branches of Agdluitsoq-fiord, 60°45′. Birch and Sorbus-thickets, heath with Ericaceae and Lichens, lake-shores, rocky brook-bed.

Julianehaab district, southern part.

Nanortalik, 60°7′, around the village.

Taserssuaq in Tasermiut Fiord (in botanical literature often called "Kinguadalen"), 60°16′. The biggest birch "forest" of Greenland, covering the bottom of a valley and the lower parts of the surrounding hills; lake shores, slow streams, thickets, bogs and swamps.

"Uiluvit". (The place visited is at ab. 60°28′, on the eastern shore of Tasermiut Fiord. The name was taken from a map and is used on the labels of the duplicates distributed. But it is a mistake, as Uiluvit is, in fact, located on the west side). Sea shore.

Frederiksdal, 60°0′. Grass-fields, bogs, water-courses and ponds.

Sangmissoq, 59°58′. manured soil, near the village.

Kangikitsoq in Ilua Fiord, 60°18′. Sea-shore, heath, bogs, ponds, thickets.

Igdlorsuit, head of eastern branch of Ilua Fiord, 60°21′. Luxuriant growth of shrubs and herbs around the Norse ruins. Alluvial sands near the front of the glacier.

Igdlorsuit, Prins Christians Sund, 60°10′. Fresh moraine, sea-shore, fertile slope.

Nunatsuk on the east coast, 60°4′. Heath, meadows, bogs, fertile slopes, hillsides.

In one respect the higher flora of southmost Greenland still needs investigation, namely in regard to the alpine parts of the districts. The highest tops surpass 2000 m., rising with steep and bare walls and wild, rugged peaks. Very little is known about the composition of the flora here, what is known we owe mostly to A. Kornerup and to a few moderate ascents made by L. K. Rosenvinge. Several plants of a more alpine or high-arctic type have been casually noticed in the lowland, where they seem to be foreigners, and probably there will be found a decided alpine life-zone above the subarctic lowland-zone. Also, more observations on the occurrence or lack of drift on the mountain tops and plateaus are needed.

When we started, we had the best of intentions to climb the hills, but partially they were difficult to ascend, partially we generally had to anchor in rather unsafe places and could not make our two Eskimos responsible for the big boat's safety for too long a time, all the more so because they were quite unacquainted with the region. Therefore we never found time enough to make an ascent.

The following list is to be understood as a supplement to Rosenvinge's list mentioned above. Generally only new localities are mentioned and when we did not find plants already known, this is also stated, as it gives an impression of how scarce or local such species are.

I owe sincere thanks to Dr. H. Dahlstedt, Stockholm, for identifying the collections of Taraxacum and Hieracium, and to Dr. J. G. Gunnarsson for revising and naming the Betula-specimens. Also to Prof. C. H. Ostenfeld and Dr. C. Christensen, Copenhagen, Dr. Selim Birger, Stockholm, and to Dr. Th. Holm, Clinton, Md. I owe thanks for valuable hints and corrections.

Whoever travels in Greenland will appreciate the great and valuable help he receives from the local officials, through their hospitality as well as by their knowledge of the local difficulties and dangers to be avoided. For this a well as for other things, not to be mentioned here, we thankfully remember the chief magistrates of the districts we visited,

Messrs. C. Langskov, Sukkertoppen; C. Simony, Godthaab; P. Ibsen, Frederikshaab; O. Hastrup, Julianehaab; and L. Mathiesen, Nanortalik.

Disko, Greenland. February, 1928.

I.

THE FLORA OF SOUTH GREENLAND, 60°—62° N. LAT., ADDITIONS AND RANGE EXTENSIONS

Woodsia ilvensis (L.) R. Br., common.

Cystopteris fragilis (L.) Bernh., common.

— *montana* (Lam.) Desv. (det. Selim Birger). New to Greenland. This interesting and unexpected addition to the flora was found S. of Kiagtût, growing in thickets on alluvial soil. The plant is generally considered a strict calciphile; the surrounding rocks are here sodalite- and nephelin-syenites and diabases.

Besides in northern and central alpine Europe the plant occurs in North America, from Labrador to Alaska, but seems nowhere to be common. The nearest stations are S. Labrador in 59° N., the St. Lawrence region of Quebec and one station on Newfoundland.

Dryopteris Filix mas (L.) Schott, quite common in thickets.

— *spinulosa* (Müll.) Kuntze var. *americana* (Fisch). Weatherb. (see Fernald: Rhodora 1915, p. 144 and 1926, p. 146), common. According to information (in litt.) by our well-known fern-authority Dr. C. Christensen of Copenhagen, all the Greenland material which has hitherto passed as *Lastrea spinulosa β intermedia* Lange Consp. p. 187 belongs to this variety, the history of which is given by Fernald l. c. Dr. Christensen continues:

> The Icelandic specimens also belong here, only one specimen slightly approaches the European form, but the Faeröese are European. In Lapland both forms seem to occur and in Denmark we have the stout typical form with blackish scales in the woods, whereas in bogs, on *Alnus*-stumps, a smaller form with lighter coloured leaves and light scales occurs. To me they seem rather to be forms from sunny situations, and it is but natural to find such north of the wooded area. . . . (in litt.).

Dryopteris Phegopteris (L.) C. Chr., common.
— *Linnaeana* C. Chr., common.
Polystichum Lonchitis (L.) Roth, common.
Athyrium sp. An immature set of specimens was found at Kangkitsoq. An indusium is present, which would bring the plant to *A. Filix femina* (L.) Roth, heretofore not observed in Greenland; but the fronds are so young and undeveloped that a definite identification is impossible.

From 6 localities on the southern part of the east coast, between 60° and 61° N., has been found an *Athyrium* which has passed as *A. alpestre* (Hoppe) Rylands. It was also found once in the Ilua Fiords of the west coast. In 1917, Fr. K. Butters has shown (Rhodora 1917, p. 203) that the American material forms a very distinct variety *americanum* Butt. Having applied to Dr. C. Christensen, he kindly revised the material and wrote:

In the Copenhagen herbarium there are only 5 sheets of *A. alpestre* from Greenland. Most of them are not well developed and difficult to identify definitely, but at least the specimens from Kuteq, 60°41′N. (Eberlin), and Nenese, 60°18′ N., (J. Vahl), are undoubtedly *v. americanum* as described by Butters.

The Icelandic specimens all belong to the European typical form, only one frond from Husavik (East-Iceland leg. H. Jónsson) approaches much to *v. americanum*.

Our specimens from America, especially specimens from Québec, show that the variety is very well characterized by Butters.

(in litt.).

Asplenium viride Huds., not seen.

Botrychium Lunaria (L.) Sw., common. A monstrous form with sporangia on upper parts of the sterile fronds was noticed at Qagssiarssuk, Ig. F.
— *boreale* Milde, Prins Christians Sund; Taserssuaq, Tas. F.; Igdlorsuit, Il. F.
— *lanceolatum* (Gmel.) Aangstr., seems to be rare in this section. By us only found S. of Kiagtût.

Equisetum arvense L., common.
— *silvaticum* L. seems to be quite rare in this section. From Taserssuaq, Tas. F. it has been taken by all previous collectors. We also took it here where it was very abundant, and from two other places in the same fiord. From Tunugdliarfik F. it has once been collected, (Rosenvinge), and we found it here S. of Kiagtût. Finally it was found at Eqaluit, Ig. F.

FERNALD states (Rhodora 1918, p. 129) that out of 194 sheets of North American specimens, 188 sheets have quite glabrous branches, while in two sheets only the branches bear minute trichome-like spicules, characteristic of the great bulk of European specimens. For the glabrous phase, the name, var. *pauciramosum* MILDE, is given, as this plant in the northern parts of its range generally is lesser branched than the type. *A* f. *multiramosum* FERN., however, occurs also in the southern parts of the American range of the glabrous variety. All the plants taken by us belong to the glabrous few-branched variety, but a specimen taken by N. HARTZ Sept. 6th, 1889, at Tassersuaq, Tas. F., is distinctly scabrous and, at the same time, "*multiramosum*", i. e., the typical European form.

Equisetum hiemale L. not seen.

— *variegatum* SCHLEICH., common.

Lycopodium Selago L. common.

— *annotinum* L. common, especially in the var. *pungens* DESV.

— *alpinum* L., common.

— *complanatum* L., not common; found by us at Björnedal; Eqaluit, Ig. F.; Amitsuarssuk; Taserssuaq, Tas. F.; Kangikitsoq.

— *clavatum* L. Taserssuaq and Uiluvit, Tas. F.

Selaginella selaginoides (L.) LINK, probably common, Eqaluit, Ig. F.; Tasiussaq, Qaq. F.; Kiagtût, Tun. F.; Igdlorsuit, Il. F.; Prins Christians Sund.

Isoetes echinospora DUR. Igaliko; Amitsuassuk; Tasserssuaq, Tas. F., abundant; Prins Christians Sund.

Juniperus communis L. v. *nana* (WIILD.) LOUD., common.

Sparganium hyperboreum LAEST., Ivigtût; Igaliko; Qagssuarssuk and Eqaluit, Ig. F.; Amitsuarssuk; Taserssuaq; Kangikitsoq; Flowering and fruiting specimens seen.

— *affine* SCHNITZL. not seen.

Potamogeton filiformis PERS. Igaliko; Qagssiarssuk, Ig. F.; flowering specimens seen.

— *groenlandicus* HÄGSTR. not seen.

— *alpinus* BALB. Qagssiarssuk, Ig. F.; sterile.

— *gramineus*, L. Igaliko and Qagssiarssuk, Ig. F.; Taserssuaq, abundant; Frederiksdal; all seen by us were sterile.

Triglochin palustre L. probably common.

Anthoxanthum odoratum L., very abundant at all places visited in the northern fiord region of the Julianehaab district, not seen in the southern region.

Hierochloë alpina (Sw.) Roem. & Schult., common.

Phleum alpinum L., common.

Alopecurus aequalis Sobol. var. *natans* (Wahl) Fern. Qagsserssuaq, Tun. F.: Qagsserssuaq, Ig. F.: Tasiússaq, Qag. F.: Amitsuarssuk, Ig. F.; Taserssuaq, Tas. F.; Frederiksdal.

Agrostis stolonifera L. Neria; Qagssiarssuk, Ig. F.: Tasiússaq, Qaq. F.: Amitsuarssuk.

— *canina*, L., common.

— *borealis* Hartm., common.

Calamagrostis Langsdorfii (Link) Trin., common.

— *hyperborea* Lange, common.

— *neglecta* (Ehrh.) Fl. D. Wett. var. *borealis* Lange seems to be much rarer than in the middle parts of West Greenland; new localities: Neria; S. of Kiagtût.

— *purpurascens* R. Br. The continuous range of this species is from 73° to about 64° N. South of that it has once been found in Tunugdliarfik Fiord at Kiagtût, 61°12′, by Kornerup, and once at the end of the Frederikshaab Glacier, 62°30′, by Holst. Kornerup's specimens are quite immature, but still they show the essential characters of the species; the woollen tufts on the leaves at the joint, the well developed lacerate ligula, the short hairs of the florets and the long awns. Probably in both cases the specimens were representatives of an alpine floral element washed down with the torrents. We searched for it, but in vain.

Deschampsia alpina (L.) Roem. & Schult., common.

— *flexuosa* (L.) Trin., common.

Trisetum spicatum (L.) Richt., common. A revision of its numerous variations in Greenland is needed. Although Fernald, in his revision of N. E. American forms, also mentions specimens from Greenland (Rhodora 1916, 195), he unfortunately does not consider the varieties described by Lange, some of which will probably be identical with American forms.

Poa alpigena (Fr.) Lindm. (*P. pratensis* Autt.), common.

— *nemoralis* L., common.

— *glauca* Vahl, common.

— *alpina* L., common. A revision of the numerous Greenland forms, (and hybrids?), of the four species mentioned, in the light of the

recent studies of C. A. M. LINDMAN, in HOLMBERG: Skandinaviens Flora H. 2, p. 198, and in Rep. Sc. Res. Norweg. Exp. to Novaya Zemlya 1921 etc. is much needed.

Poa annua L. Sangmigssoq, abundant around the settlement.

Phippsia algida (SOL.) R. BR. Only noticed at Ivigtût.

Puccinellia an *retroflexa* (CURT) HOLMB. subsp. *borealis* HOLMB.? A well sized, more or less erect *Puccinellia*-species was quite common. It probably belongs here.

— *maritima* (HUDS.) PARL. searched for without success.

— *phryganodes* (TRIN.) SCRIBN. & MERR. Björnedal; Tasermiut F.; Kangikitsoq; Igdlorsuit, Il. F.; Prins Chr. Sund.

Festuca ovina L. sens. latissimo, common.

— *rubra* L. s. latiss., common. Also the Greenland species and varieties of Festuca need a revision.

Nardus stricta L., very abundant in the Tasermiut- and Ilua Fiords, also seen at Nunatsuk on the east coast, but here confined to moist depressions, and growing exactly to the limit of the lasting snow in winter.

Agropyron violaceum (HORN.) LANGE. Björnedal; Amitsuarssuk; Taserssuaq; Tas. F.

Elymus arenarius L. var. *villosus* E. MEY., common.

Eriophorum Scheuchzeri HOPPE, common.

— *angustifolium* ROTH, common.

Scirpus caespitosus v. *callosus* BIG., common.

— *pauciflorus* LIGHTF., Qagssiarssuk, Ig. F.

Heleocharis uniglumis (LINK). SCHULT., not seen.

Carex nardina FR. Kiagtût; Tasiussaq, Qaq. F.

— *capitata* L., Eqaluit, Ig. F.; Qaqortoq; Tasiussaq, Qaq. F.

— *gynocrates* DREJ., Kiagtût.

— *scirpoidea* MICHX., common.

— *microglochin* WAHL., Prins Christians Sund.

— *incurva* LIGHTF., rare, Qagssiarssuk, Tun. F.

— *Macloviana* d'URV., common.

— *pratensis* DREJ., Qagssiarssuk, Ig. F.; Qaqortoq.

— *Lachenalii* SCHK., common.

— *glareosa* WAHL., common.

— *canescens* L., common.

— *brunnescens* (PERS.) POIR., common.

— *bicolor* ALL., not seen.

— *rufina* DREJ., not seen.

— *rigida* GOOD., common.

Carex Goodenoughii GAY., probably common in the northern part of the Julianehaab district, additional localities: Qagssiarssuk, Tun. F.
— *subspathacea* WORMSKJ., not seen.
— *salina* WAHL., Qagssiarssuk, Ig. F.; "Uiluvit"; Nunatsuk; all our specimens were immature and cannot be definitely identified; at "Uiluvit" they were growing in great abundance along the border of a lagoon, forming zones. The plants of the innermost zone, growing between willows, are tall and approach var. *Kattegatensis* FR. Others seem to be identical with *C. groenlandica* LANGE or *C. hyperborea* DREJ. The plants from Nunatsuk grew in a swampy depression near the sea, but with no other halophilous plants between. They are nearer the type than the others, (suggestions by Dr. TH. HOLM).
— *Lyngbyei* HORN., not seen.
— *alpina* SW., common.
— *Buxbaumii* WAHL., not seen.
— *stylosa* C. A. MEY., common, also in the interior of the fiords.
— *atrata* L., common.
— *deflexa* HORN., Kvanefjord; Kiagtût; Tasiússaq, Qaq. F.; Taserssuaq, Tas. F.; Kangikitsoq.
— *supina* WAHL. seems to be much rarer than in the middle sections of West Greenland. Formerly, it had been recorded only from Qagssiarssuk, Ig. F. where we found it again; also at Igaliko and Kiagtût.
— *rariflora* (WAHL.) SM., common.
— *panicea* L., not seen.
— *capillaris* L., common.
— *Oederi* RETZ., hitherto only recorded from Igaliko; we found it at Qagssiarssuk, Ig. F.
— *rostrata* STOKES, heretofore only from Igaliko and Taserssuaq where we found it again, in the last place covering a very wide area; also at Qagssiarssuk, Ig. F.
— *rotundata* STOKES is probably common, additional localities seen: Narssalik; Qagssiarssuk, Tun. F.; Eqaluit, Ig. F.; Qaqortoq; Taserssuaq, Tas. F.; Frederiksdal; Nunatsuk.

Juncus filiformis L., Eqaluit in Kuanersoq; Qagssiarssuk and Eqaluit, Ig. F.; Qaqortoq; Taserssuaq, Tas. F.; Kangikitsoq.
— *arcticus* WILD., S. of Kiagtût, Tun. F.; Qagssiarssuk, Ig. F. Tasermiut F., several places; Igdlorsuit, H. F.
— *nodulosus* WAHL., additional locality: Eqaluit, Ig. F.
— *squarrosus* L., not seen.

Juncus bufonius L., abundant at Igaliko where it has been collected before. Also at Narssaq, Tun. F.
— *albescens* (LANGE) FERN. (*J. triglumis* AUTT. de. fl. Grl., non L.), Björnedal; S. of Kiagtût, Tun. F.; Taserssuaq, Tas. F.
— *trifidus* L., common.
Luzula parviflora (EHRH.) DESV., common.
— *arcuata* WAHL., not seen.
— *confusa* LINDEB., probably rare.
— *multiflora* (RETZ.) LEJ., common.
— *frigida* (BUCH.) SAM., probably common.
— *spicata* (L.) LAM., common.

Tofieldia palustris HUDS., common.
Streptopus amplexifolius (L.) DC., Neria; Björnedal; Qaqortoq; Amitsuarssuk.

Orchis rotundifolia BANKS., by us only found at Qagssiarssuk, Ig. F. where it has been found before. The specimens were abundant in a very dry *Dryas*-Lichen-heath as well as in swampy depressions among mosses under willows.
Habenaria straminea FERN. Rhodora, 1926, p. 174 (*H. albida* AUTT. de. fl. Grl. non *H. albida* (L.) R. BR.), common. FERNALD has shown that the plant which has passed as *H. albida* in Newfoundland, Greenland, Iceland and the Faerö Islands is specifically distinct from the European. Our plants have a very distinct scent of vanilla, whereas the Swedish and Alpine plants are described as, "faintly scented".
— *hyperborea* (L.) R. BR. (*Limnorchis hyperborea*, RYDB., Bull. Torr. Bot. Cl. 28, 1901, p. 620). The small plant with the slender spur, equalling typical material from Iceland, seems, in Greenland, to be confined to the area of the larger birch. We found it abundant at Igaliko, Qagssiarssuk, Ig. F., I have also specimens from Lichtenau and Ivigtût. Where it occurred, generally there were no specimens of the much commoner subsequent variety.
— *hyperborea* var. *major* LANGE (*Limnorchis major* RYDB. l. c., p. 617), common. Also this plant is fragrant, recalling the scent of *Dianthus*.
Listera cordata (L.) R. BR. Probably common; additional localities: Björnedal; Amitsuarssuk, abundant; Kangikitsoq; Igdlorsuit, Ilua F.
Coralliorrhiza trifida CHAT. seems to be rare; Neria.

Salix herbacea L., common.
— *Uva Ursi* PURSH., Björnedal.

Salix chloroclados Flod. (*S. groenlandica* (And.) Lundstr.), noticed in nearly all places visited but, as has already been said by Rosenvinge, markedly less abundant than in the middle parts of West Greenland.

— *glauca* L., everywhere. The more or less erect willows forming thickets in South Greenland seemed to us rather different from what we generally supposed to be *S. glauca* at higher latitudes. According to Floderus, (Medd. om Grl. 63, 1923), probably no pure i. e. *S. glauca* free of hybridogenous admixture, is to be met with in Greenland, but these approach very close to the definition of what pure *S. glauca* should be, as it is given in Floderus' work, p. 122.

Alnus crispa (Ait.) Pursh. (*A. Alnobetula* (Ehrh.) Hartig, var. *repens* (Wormskj.) Winkler). Neria; Björnedal, abundant.

Betula. The southern part of Greenland is, as is well known, characterized by one dwarf-birch *B. glandulosa* Michx. and one higher and stouter species allied to *B. pubescens* Ehrh., which on its best localities becomes tree-like, at its northern limit and in higher altitudes only shrubby. Also, hybrids between them have been suggested by previous writers.

Our collections have brought nothing new as to the distribution, but they were handed over to Dr. J. G. Gunnarsson, the author of the very elaborate study of the birches of Scandinavia. (J. G. Gunnarsson: Monografi över Skandinaviens Betulæ, Arlöv 1925). Dr. Gunnarsson's naming of the tree-birch and its several hybrids with *B. glandulosa* is now at hand, but will no doubt be published by the author elsewhere.

Rumex domesticus Hartm., not seen.

— *Acetosa* L., no additional localities.

— *Acetosella* L., common.

Oxyria digyna (L.) Hill., common.

Koenigia islandica L., common.

Polygonum viviparum L., common.

— *heterophyllum* Lindm. var. *boreale* (Lange) Lindm. emend., Sv. Bot. Tidsskrift. 6. 1912, p. 67. (Syn. *P. aviculare* L. var. *borealis* Lange: Consp. Fl. Grl. 1880, p. 105; *P. islandicum* Meissn. sec. Autt. Americ.), no additional localities, but quite common in inhabited places.

Atriplex (an *glabriusculum* Edmonst.?) was found by N. Hartz at Taser-

miutsiaq, Tas. F., very distant from the present settlements, but not very far from Norse ruins. We found it again on the same shore of the fiord, but farther outward, at about 62°28′ N., where it grew very abundantly. HARTZ' as well as our specimens are immature and cannot be definitely identified. Prof. C. H. OSTENFELD suggests (in litt.) that they belong to *A. longipes* (DREJ.) emed. TURESSON.

Montia lamprosperma CHAM., Narssaq and Qagssiarssuk, Tun. F.; Amitsuarssuk; Frederiksdal; Sangmigssoq.

Stellaria media CYR., very common, in inhabited places, but observed nowhere else by us.
— *longipes* GOLDIE, much rarer than farther north.
— *humifusa* ROTTB., common.
— *borealis* BIG. (*St. calycantha* BONG.), common.
Cerastium cerastioides (L.) BRITTON, common.
— *alpinum* L., common.
— *caespitosum* GIL., Eqaluit; Kuanersôq.
— *caespitosum* subsp. *alpestre* (LINDBL.) HARTM., probably common; additional localities: Qagssiarssuk and Eqaluit, Ig. F.
Sagina nodosa (L.) FENZL. Igaliko and Qagssiarssuk, Ig. F.
— *caespitosa* (J. VAHL) LANGE, no additional localities.
— *intermedia* FENZL., Taserssuaq, Tas. F.; Igdlorssuit, Il. F.; Nunatsuk.
— *saginoides* (L.) DALLA TORRE (*S. Linnaei* PRESL.), Neria; Nunatsuk.
— *procumbens* L., not seen.
Minuartia biflora (L.), not seen.
— *rubella* (WAHL.) GRAEBN. Qagssiarssuk, Tun. F.; Amitsuarssuk; Taserssuaq, Tas. F.; probably common.
— *groenlandica* (RETZ.) OSTENF., no additional localities.
Honckenya peploides (L.) EHRH., v. *diffusa* HORN., Tasermiut F., several stations; Kangikitsoq; Igdlorssuit; Prins Christians Sund; probably common in suitable places.
Viscaria alpina (L.) DON., very common. In the southern districts white flowered specimens are more common than pink-flowered.
Silene acaulis L., common.

Coptis trifolia (L.) SALISB., common.
Ranunculus reptans L., Qagssiarssuk, Tun. F.; Qagssiarssuk and Eqaluit, Ig. F.; probably common.
— *hyperboreus* ROTTB., Narssalik; Qaqortoq; Amitsuarssuk.
— *pygmaeus* WAHL., Julianehaab (MELDORF); Nunatsuk.

Ranunculus acris L., very common, also on the east coast, at Nunatsuk.

— *confervoides* (Fr.) Asch. & Gr., Qagssiarssuk, Ig. F.; Amitsuarssuk; Taserssuaq, Tas. F.

Thalictrum alpinum L., common.

Papaver radicatum Rottb. (an incl. *P. nudicaule* L. em. Lundstr.?), rare; Frederikshaab; Neria; Ivigtût; Narssaq, Tun. F.; Qagssiarssuk, Ig. F.; Amitsuarssuk (white-flowered).

Subularia aquatica L., found again at Taserssuaq, Tas. F.; Frederiksdal.

Cochlearia officinalis L. var. *groenlandica* (L.) Gelert and v. *oblongifolia* (Dc.) Gelert, common.

Roripa islandica (Oed.) Sch. & Thell., very rare: Ivigtût (Lindhard): Qagssiarssuk, Ig. F.

Cardamine pratensis L., var. *angustifolia* Hook., Björnedal; Qagssiarssuk, Tun. F.; Qagssiarssuk, and Eqaluit, Ig. F.; Amitsuarssuk: Taserssuaq, Tas. F.

— *pratensis* var. *palustris* Wimm. & Grab., Qagssiarssuk, Tun. F.

— *bellidifolia* L., not seen.

Capsella Bursa pastoris L., only seen at Narssaq, flowering specimens, where it has also previously been found, f. inst. by Meldorf: big, fruiting specimens.

Draba incana L., very common.

— *stylaris* Gay, not seen.

— *aurea* M. Wahl, common.

— *nivalis* Liljebl., not seen.

Arabis alpina L., not very common.

— *Holboelli* Horn., not seen.

Drosera rotundifolia L., not seen.

Rhodiola rosea L., common.

Sedum villosum L., no additional localities.

— *annuum* L., common.

Parnassia Kotzebuei Ch. & Schl., no additional localities.

Saxifraga Aizoon Jacq., common.

— *oppositifolia* L., common.

— *stellaris* L., common.

— *nivalis* L., less common than farther north.

— *tenuis* (Wahl.) H. Smith, Kiagtût, Tun. F., amongst the preceding species (Kornerup).

Saxifraga aizoides L., local: Neria; Björnedal; Taserssuaq, Tas. F.; Prins Christians Sund.
— *cernua* L., rare, at least in the lowland: Amitsuarssuk; Taserssuaq, Tas. F.
— *rivularis* L., also quite rare in the lowland: Neria; Qaqortoq; Tasiussaq, Qaq. F.; Nunatsuk.
— *groenlandica* L., less abundant at lowland stations than farther north.

Sorbus decora (SARG.) C. K. SCHN., in all Alnus- and Betula-thickets visited, but nowhere dominant.
Rubus Chamaemorus L., not seen.
— *saxatilis* L., known from a single spot in Tasermiut F. only. We searched for it without success.
Comarum palustre L.; rather rare, noticed at four localities of which two are new: Amitsuarssuk; Nunatsuk. Here not seen in lakes or ponds as it occurs farther north, but only in patches of Sphagnum in the thickets.
Potentilla maculata POURR. (*P. Crantzii* BECK), common.
— *pacifica* HOWELL (*P. anserina β groenlandica* SER.), not rare.
— *anserina* L. (typica), not seen.
Sibbaldiopsis tridentata (SOL.) RYDB., very common.
Sibbaldia procumbens L., not abundant, at least in the lowland.
Dryas integrifolia M. VAHL, very scarce, at least in the lowland; Neria, rare (according to EUGENIUS' labels); Igaliko; Qagssiarssuk, Ig. F., very abundant; not seen in the southern parts.
Alchemilla alpina L., very common.
— minor, subsp. *filicaulis* (BUS.) LINDB. FIL., Eqaluit in Kuánersôq; Björnedal; Julianehaab (MELDORF); Kangikitsoq; Igdlorssuit, Il. F.; Prins Christians Sund; probably common.
— *glomerulans* BUS. apparently rarer than the preceding species: Neria; Björnedal; Nunatsuk.

Vicia Cracca L., at Igaliko, its only occurrence, it grew abundantly amongst grass in an overgrazed meadow. The plants were dwarfish and sterile.
Lathyrus maritimus (L.) BIG. Except in the Tasermiut Fiord, present everywhere from the Tunugdliarfik Fiord to Nunatsuk, often very abundantly.

Geranium silvaticum L., only found once, not seen by us.

Callitriche verna KÜTZ., not seen.

Callitriche hamulata Kütz., Björnedal; Taserssuaq, Tas. F.; Frederiksdal.
— *anceps* Fernald, Kangikitsoq.

Viola Selkirkii Pursh, Eqaluit in Kuánersôq.
— *palustris* L., common.
— *montana* L., Qagssiarssuk, Tun. F.; Igaliko and Eqaluit, Ig. F.; Tasiússaq, Qaq. F.
— *labradorica* Schrank, Eqaluit in Kuánersôq; Neria; Eqaluit, Ig. F.; Amitsuarssuk.

Epilobium palustre L. var. *labradoricum* Hausskn., additional localities: Neria and Narssalik, where it is common; Amitsuarssuk; Prins Christians Sund.
— *anagallidifolium* Lam., common.
— *lactiflorum* Hausskn., Neria; Amitsuarssuk; Taserssuaq, Tas. F., very abundant; Kangikitsoq; Igdlorssuit, Il. F.; Prins Christians Sund; probably common.
— *Hornemanni* Reichenb., seems to be less common than the preceding species, additional localities: Neria; Tasiussaq, Qaq. F.; Uiluvit.
Chamaenerium angustifolium (L.) Spach, var. *intermedium* (Wormskj.) Lange, common.
— *latifolium* (L.) Spach, common.
— *latifolium* f. *elatior* Hausskn., Björnedal; Prins Christians Sund.

Myriophyllum alterniflorum Dc., found in three places, of which Taserssuaq, Tas. F. seems to be a new locality.
Hippuris vulgaris L. Quite common.

Ligusticum scoticum L. Quite common; additional localities: Björnedal; Amitsuarssuk; Frederiksdal.
Archangelica officinalis Hoffm., common.

Cornus suecica L., very common.
— *canadensis* L., searched for in vain.

Empetrum nigrum L., common.
— var. *purpureum* (Raf.) Dc.
Redfruited crowberries have been reported several times from Atlantic North America and from North Greenland and Ellesmereland. They have sometimes erroneously been considered identical with the South American species. Fernald and Wiegand have shown that in Atlantic North America, besides *E. nigrum*, there occur

two redfruited species, *E. Eamesii* and *E. atropurpureum*, which are distinct from the South American species but nearer allied to them than to *E. nigrum*. And lately FERNALD has found again the redfruited form of *E. nigrum*. The several very interesting stages in the development of our knowledge of these plants and their history are given in the following papers.

M. L. FERNALD: The Chilian Empetrum in New England. Rhodora 1902. p. 147.
H. G. SIMMONS: The Vascular Plants in the Flora of Ellesmereland, 1906, p. 43.
— A revised list of the Flowering Plants and Ferns of N. W. Greenland 1909, p. 59.
M. L. FERNALD & K. M. WIEGAND: The Genus Empetrum in North America, Rhodora 1913, p. 211.
M. L. FERNALD: Empetrum nigrum f. purpureum (RAF.) n. comb.

From West Greenland redfruited crowberries have never been reported, and I have for many years searched for them in vain. Berries which do not attain full maturity before the frosts set in, will the next spring remain on the shrub in a discoloured, reddish-brown state, and have an acid taste. This case is very common.

Amongst plants dried and sent by Mr. J. Eugenius, 1925, was a set of *Empetrum nigrum*, taken on Narssalik Island, 61°38′, on Aug. 23nd, with partially unripe and greenish, partially ripe and purplish fruits, but in all other respects a typical *E. nigrum*.

Pirola rotundifolia L. var. *arenaria* MERT. & KOCH. As to the distinguishing characters separating this plant from its nearest allies: *P. rotundifolia*, typical, *P. grandiflora* and *P. americana* see LANGE: Consp. Fl. Grl. 1880, p. 84; WARMING: Medd. om Grl. 36, p. 60, 1912; FERNALD: Rhodora 1920, p. 121; FERNALD: RHODORA 1904, p. 197; H. ANDRES: Österr. Bot. Zeitschr. 1913 (not accessible to me, quoted in HEGI: Ill. Fl. v. Mittel Europa vol. V. 3. T., p. 1587). According to the last mentioned author, the plant should be scentless, which is doubted by BRAUN-BLANQUET, who treated the *Pirolaceae* in HEGI's Flora. And, as a matter of fact, on the labels of specimens from Newfoundland (Gray Herbarium Nr. 6000) expressly stated "fragrant".

This plant seems to be very rare in Greenland. From the district here treated I have seen a specimen from Ivigtût (leg. NORMAN) and one from Neria (leg. EUGENIUS).

— *grandiflora* RADIUS, very rare, at least in the lowland, by us only seen S. of Kiagtût, Tun. F., sterile specimens. It has been taken twice, both times flowering, in the same fiord by KORNERUP, one set from an altitude of 1000 ft.; the other in a bog.

Pirola minor L., common.

Ledum groenlandicum OED., common.
Rhododendron lapponicum L., common.
Loiseleuria procumbens (L.), DESV., common.
Phyllodoce coerulea (L.) BAB., common.
Harrimanella hypnoides (L.), COV., quite scarce in the lowland, but, according to ROSENVINGE, common on the hills.
Andromeda glaucophylla LINK., Narssalik (see: part III, p. 32).
Oxycoccus quadripetalus GIL., v. *microphyllus* (LANGE), (see: part IV, p. 38).
Vaccinium uliginosum L. var. *alpinum* BIG. (= subsp. *microphylla* LANGE) and var. *pubescens* HORN. are both common. Most of the lowland plants belong to the last-mentioned. The two varieties seem to be different, not only in morphology, but also in distribution, flowering time and in the fruits, and a renewed study of them is needed.
— *Vitis Idaea* L., var. *minus* LODD. (= var. *pumilum* HORN.), very rare, not seen by us.

Diapensia lapponica L., rather scarce.

Primula stricta HORN. Only once recorded for the section, not seen by us.
— *egaliksensis* WORMSK., very sparingly at its type locality: Igaliko.

Statice maritima MILLER, quite common on sea-shores.
— *sibirica* (TURCZ.) LEDEB. (an = *St. labradorica* (WALLR.) HUBB. & BLAKE?), very rare, at least in the lowland.

Gentiana nivalis L., common, also with white flowers.
— *aurea* L., numerous localities, known before; Igdlorsuit, II. F.
— *serrata* GUNN., only seen at Igaliko.
Lomatogonium rotatum (L.) FR., seen, but no additional localities.
Menyanthes trifoliata L., only seen at Igaliko.

Thymus arcticus DURAND (= *Th. Serpyllum* v. *prostratus* HORN.; see RONNIGER: Contributions to the knowledge of the genus *Thymus*. Rec. Bot. Exch. Cl. 1923, p. 237). Common.

Limosella aquatica L., only once reported in the section, not seen by us.
Veronica alpina L. sens. latiss., very common, most of the plants from this section seem to belong to the var. *villosa* (WORMSKJ.) LANGE.

The Greenland forms of this species still need a revision, as F. W. PENNELL's treatment: "Veronica" in North and South America, Rhodora 1921, is very insufficient and by lack of descriptions other than those given in the keys, not convincing. PENNELL considers the northern *V. alpina* different from the species in the Alps of Central Europe, and gives the range of the former as Scandinavia, Scotland and East Greenland, whereas *V. Wormskjoldii* R. & SCH. (= v. *villosa*) is said to be confined to West Greenland.

Such a difference in distribution would certainly strengthen the author's opinion, but, unfortunately, the specimen quoted from "Flora Danica" as well as the single Greenland specimen of *V. alpina* he has seen, both came from Disko, which is not located in East Greenland.

Veronica fruticans JACQ., common.

Euphrasia arctica LANGE, common.

Bartschia alpina L., common.

Alectorolophus groenlandicus (CHAB.) OSTENF., common.

— *groenlandicus* var. *Drummond-Hayi* (BUCH. WHITE) OSTENF. (= *A. borealis* STERN. an = *Rhinanthus oblongifolius* FERN. ?). Rarer than the preceding species and not growing in company with it. S. of Kiagtût, Tun. F.; Igaliko and Qagssiarssuk, Ig. F.; Sydpröven; Lichtenau; Taserssuaq, Tas. F.; Igdlorsuit, Il. F.; Frederiksdal. Including the two stations mentioned by OSTENFELD (Bot. of the Färöes, p. 55) the total range in Greenland is from 60°30' N., on the East Coast, to ab. 61°10′ N., on the West.

Pedicularis flammea L. According to ROSENVINGE, common, which we cannot corroborate. South of 60°30′ we only found it, very sparingly, at Taserssuaq, Tas. F.

Pinguicula vulgaris L., common.

Utricularia minor L., not seen.

Plantago juncoides LAM., v. *glauca* (HORN.) FERN. (incl. *P. maritima* Autt. de Fl. Grl. and *P. borealis* LANGE, see: FERNALD: The Maritime Plantains of North America, Rhodora, 1925, p. 95).

Galium Brandegeei GRAY, probably not rare; (see part II, p. 24).

— *triflorum* MCHX., quite common in willow- and birch-thickets and on fertile, grassy slopes.

Linnaea borealis L., var. *americana* (FORB.) REHDER. Neria. Only two localities previously known in the section.

Campanula uniflora L., not seen.
— *rotundifolia* L., common.

Erigeron compositus Pursh., not seen, probably alpine.
— *uniflorus* L., emend. Vierh., quite scarce, at least in the lowland. Neria and Frederikshaab; Taserssuaq, Tas. F.
— *borealis* (Vierh.) Simm., common.
Antennaria groenlandica Porsild, quite common.
— ? *intermedia* (Rosenvinge) Porsild, Igdlorsuit, Ilua-F.; not typical, perhaps another species.
— *alpina* (L.) R. Br., rare or probably alpine. Neria; Prins Chr. Sund.
Gnaphalium supinum L., quite common.
— *norvegicum* Gunn., common.
— *uliginosum* L., not seen.
Achillea Millefolium L., f. *nigrescens* E. Mey. (*A. nigrescens* Rydb.), seen at several localities, but none new.
Matricaria inodora L., var. *grandiflora* (Hook.) Ostenf. (= *M. i.* v. *phaeocephala* Rupr.), only seen at Igaliko, where it was known before.
Leontodon autumnalis L., no additional localities. The specimens collected belong to the f. *asperior* Wahl.

TARAXACUM AND *HIERACIUM*

I have to thank Dr. H. Dahlstedt of Stockholm for his most valuable help in identifying our specimens of these genera. Unfortunately, our collections here were very insufficient, mostly because the season was so unfavourably late, that the Hieracium species, *H. alpinum* excepted, were just coming into flower when we had to leave the district. Still it would seem that especially the *Taraxacum*-flora in southmost Greenland deserves a closer investigation than we could undertake.

Taraxacum.

Group *Ceratophora.*

— *brachyceras* Dahlst., S. of Kiagtût, Tun. F.; Qagssiarssuk, Ig. F. According to Dahlstedt (Arkiv f. Bot. B. 5. Nr. 9, p. 20, 1906) formerly known from Arctic Europe, Spitsbergen and N. E. Greenland.
— *leptoceras* Dahlst., n. sp., Qagssiarssuk, Ig. F.

Group *Spectabilia.*

— *croceum* Dahlst., Narssalik; Björnedal; Qagssiarssuk, Tun. F.; Eqaluit. Ig. F.; Igdlorsuit, Il. F.; Prins Christians Sund. Probably common.
— *pseudonaevosum* Dahlst., n. sp., Uiluvit, Tun. F.; Kangikitsoq.
— *maurostylum* Dahlst., n. sp., Eqaluit, Ig. F.

Hieracium alpinum L., common.
— *livido-rubens* ALMQ., Taserssuaq, Tas. F.; Prins Christians Sund.
— *hyparcticum* ALMQ., Eqaluit in Kuánersóq; Björnedal; Amitsuarssuk.
— *groenlandicum* ALMQ., Prins Christians Sund.
— *groenlandicum* subsp. *silvaticiforme* DAHLST. ad int., Taserssuaq, Tas. F. Specimen very imperfect.
— ? *amitsokense* ALMQ., Qagssiarssuk, Tun. F.
— *rigorosum* (LST.) ALMQ., Qagssiarssuk and S. of Kiagtût, Tun. F. Noticed on numerous other localities, but as not yet flowering, not collected. Probably common.

II.

GALIUM BRANDEGEEI GRAY.

A very tiny species of *Galium* was first found in Greenland by J. VAHL, at Julianehaab, 61° N., and Godthaab, 64°10′ N. HORNEMANN identified it as *G. uliginosum* in Øk. Pl. vol. 2, p. 128, from which work it was taken over in HOOKER's, "Outlines of the distribution of Arctic plants", 1861, in spite of the fact that VAHL had identified and distributed it with printed labels under the name of *G. palustre*. When JOH. LANGE, 1857, published a list of Greenland plants in the appendix to RINK's Grønland, vol. II, he called it *G. palustre*, v. *minus*, the varietal name, only as a "nomen nudum". In his "Conspectus", from 1880, he adds, p. 92, the diagnosis:

2—3 pollicare, foliis obovato-lanceolatis, obtusis, minutis (5—6 mm. longis); cyma depauperata, saepe ad florem unicum reducta. Habitus fere G. trifidi L., quod tamen pedicellis capillaribus, corollis trifidis etc. distinguitur.

Later, the small *Galium* has been found and published with LANGE's name from Igaliko, 61° N., (BERLIN); from Sydpröven, 60°26′ N., (HARTZ); Tunugdliarfik Qingua, 61°15′ N., (ROSENVINGE). The latter author has also seen specimens taken by J. VAHL at Kapisilik, 64°20′ N. And lastly, and somewhat unexpectedly, it was stated by KRUUSE to be found on the East Coast, at Tasiussaq, 65°37′ N.

During the winter of 1924—25, A. E. PORSILD was preparing him-

self for an intended collecting trip to South Greenland, studying herbarium specimens of types not occurring in the sections of Greenland where he had formerly been. As to the small southern *Galium*, we had only specimens (duplicate) from KRUUSE's collection mentioned above. In comparing these with some European material of *G. palustre*, he realized that the East Greenland plant must be specifically different. One of its most important differences had already been noticed by KRUUSE, namely the trimerous flowers. About his plants KRUUSE says (Medd. om Grl. 30, p. 255):

> Found but in one place on the edge of a pond among moss and grass, but here very numerous. 3—10 cm. long, richly branched, creeping shoots with four-leaved whorls. The joints of the stems 0.7—1 cm. long. The leaves 1—5 mm. long. ca. 1.5 mm. broad. The flowers 1—4 in cyme, abt. 1 mm. broad, the corolla white, tripetalous, the fruit 0.5—0.8 mm. in diameter. Flowers from the 10th of July till the 10th of August, in fruit on the 20th of August.

Fig. 1. *Galium Brandegeei* GRAY from East Greenland, Tasiússaq, 65°37′ N., leg. C. KRUUSE; slightly enlarged.

Of course, the species first to suggest itself would be *G. trifidum*, which occurs in Iceland, but as the East Greenland specimens seemed rather different from European material of this species, we turned to American literature and soon found that the specimens fairly matched the description of *G. brevipes* Fern. & Wieg.

LANGE's remark, that *G. trifidum* should differ from his "*palustre*, var. *minus*" by its trifid corolla, can only mean that he had actually seen a tetramerous flower. We were therefore prepared to meet any small-sized *Galium* occurring in Northern Europe or America, trimerous as well as tetramerous. We hunted many times for them in vain, until we got the first, growing in *Sphagnum* and other mosses along the borders of lakes and ponds. This and all subsequent ones were, however, *G. Brandegeei*, according to our excerpts and notes, and we did not succeed in finding any tetramerous species. We found *G. Brandegeei* at the following places: Agdluitsoq Fiord at Amitsuarssûp Qingua,

60°45′ N., in *Sphagnum* at the border of lakes under birches and willows; Igaliko Fiord at Qagssiarssuk, 60°53′ N. under similar conditions; Tunugdliarfik Fiord at Qagssiarssuk, 60°10′ N. and Sydpröven, 60°26′ N., in ponds near the settlement, probably the same place where N. HARTZ found it.

Fig. 2. *Galium Brandegeei* GRAY, from Québec, Matane County, FERNALD Pass leg. M. L. FERNALD, LUDLOW GRISCOM, K. K. MACKENZIE, A. S. PEASE and L. B. SMITH. Natural size.

In all places, where seen, it grew plentifully, in Agdluitsoq, f. inst., over miles at a stretch, and, on closer investigation than time would permit us, it will certainly prove to be more common. As the tiny stems project barely 1—2 cm. above the moss, it is very inconspicuous and it has to be expressly searched for every suitable place.

A. E. PORSILD took all our material to Copenhagen. Prof. M. L. FERNALD generously supplied authentic American material of *G. Brandegeei* and related species. Having compared our plants with the available material, he reports:

Without much doubt I should say that all earlier collections from West-Greenland are uniform with ours, i. e., belong to the *G. Brandegeei* GRAY, and not to *G. palustre* or *G. trifidum* either. Still KRUUSE's plants seem to me to be somewhat different.

From Iceland only three poor sets occur in the Copenhagen herbarium. They

are surely not typical *G. trifidum*, but the material is too scanty for a definite identification.

All Scandinavian material I have seen is *G. trifidum*,

and later from America he adds:

Having now seen a large material of *G. Brandegeei* in the Gray- and Ottawa-herbaria, I am somewhat in doubt about the taxonomic unity of that species or about its range in variation.

As Linnaeus' *G. trifidum* came from Canada, a careful comparison between the European and American material of this species as well as with the related species probably should be suggested.[1])

A. E. Porsild (in litt.).

The type of *G. Brandegeei* came from New Mexico, Valley Rio Grande on Los Piños Trail, (Ab. 37 N.), 9000 feet altitude. It was described by Asa Gray in Proc. Am. Ac. 1877, p. 58.

Caespitose-depressum, parvum, glabrum, laevissimum. Radicibus fibrosis, foliis quaternis obovatis vel spathulatis fere aveniis lin. 1—3 longis. Pedunculis unifloribus solitariis binisve nudis. Flore albido semi-lineam longo. Fructu laevi glabro. —

Twenty years later, K. Wiegand published an extensive revision of the Nth. American *Galium*-species, allied to *G. trifidum*, in Bull. Torr. Bot. Cl. 24, p. 389—403, 1897.[2])

His description runs:

Perennial and caespitose, forming dense mats, stems low and prostrate or ascending (5—12 cm. long), slender and rather densely leafy, smooth or nearly so; branches when present solitary: leaves in fours, unequal, obovate-spathulate, small (10 mm.) or less; rounded at the apex, cuneate at the base, somewhat fleshy, dull on both surfaces, veins indistinct, margins and midribs glabrous; flowers lateral, commonly geminate, on glabrous arcuate pedicels which are as long or longer than the leaves, corolla of med. size, white, 3-parted, lobes broadly ovate, obtuse, fruit glab. Endosperm spherical hollow, annular in cross-section.

The specimens from our collections agree very well with the descriptions given and with specimens from Québec and Newfoundland, only our plants are somewhat more branched. In American literature the plant is said to grow in springy places, whereas we took ours in *Sphagnum*, but in one specimen from the Tabletop Mts. in Québec, 1100 m. alt., (Gray Herbarium N. 26020), the roots were entangled in a clump of *Sphagnum*.

[1]) Already Ruprecht noticed that American and Russian specimens were slightly different. Fl. Samojed. Cisural., Beitr. Pfl. Russ. Reich. Lief. 2., St. Petersb. 1845, p. 38.

[2]) I have had no access to these papers, only the quotations having been copied for me.

The specimens from East Greenland collected and described by KRUUSE (see above) are smaller than ours and in habit, branching and dimensions come nearest to *G. brevipes*, FERN. & WIEGAND, but stems, leaf margins and midribs, as well as the peduncles, are perfectly glabrous, so it must be a dwarfish form of *G. Brandegeei.*

Fig. 3. *Galium Brandegeei* GRAY, from South Greenland, Amitsuarssoq 60°45′ N., leg. A. E. PORSILD & M. P. PORSILD, slightly enlarged.

What is *Galium brevipes* FERN. & WIEG.?

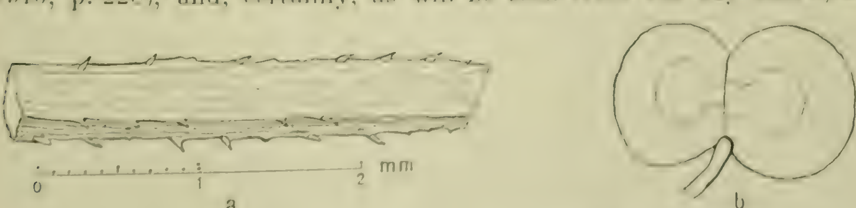
The original description of this plant runs:

humile valde implicatum, caulibus 0.5—3 dm. longis ramosissimis glabrescentibus vel paulo retrorso-scabris, internodiis longioribus 1—3 cm. longis; foliis plerumque 4is subinequalibus oblanceolatis vel oblongo-lanceolatis obtusis cuneatis 2—10 mm. longis 1-nerviis glabris vel margine et subtus in nervo scabris; floribus axillaribus solitariis vel binis; pedicellis arcuatis glabris demum 0.5—4 mm. longis; corollis minutis albidis, lobis 3 obtusis; fructu glabro, carpellis maturis 0.8—1 mm. diametro, endospermo in sectione transversali annulare.

(Rhodora 1910, p. 78).

The type came from an exsiccated marlpond near the mouth of the Grand River, Gaspé County, Québec. Beyond this, two localities from Maine and one from Minnesota are known. Quite recently, FERNALD has withdrawn this species, making it a synonym under *G. Brandegeei*, ("Persistence" etc., p. 283, in a footnote, without giving reasons for the transfer). Due to the courtesy of Prof. FERNALD, I have been able to investigate good specimens, also of the type collection, over twenty individuals, and they are all, seen under microscope, minutely retrorse-scabrous on stems and leaf margins (see Fig. 5 a). As *G. Brandegeei* is best defined from all the others by its glabrous stems, leaves and peduncles, a transfer to this species therefore cannot be effected without changing the definition of *G. Brandegeei* considerably. In its richly branched stem *G. brevipes* recalls dwarfish specimens of *G. trifidum*, and we learn that the authors of it first considered it, at least partially, as the var. *subbiflorum* WIEG. of *G. trifidum*. But, on the other hand, the peduncles and the shape of the leaves in *G. trifidum* are widely different. One part of the variety *subbiflorum* was later transferred by WIEGAND to *G. Claytoni* MICHX., (Rhodora 1910, p. 228), and, certainly, as will be seen from the key below, *G.*

Fig. 4. *Galium brevipes* FERNALD & WIEGAND, from Maine, Aroostook County, New Limerick, leg. M. L. FERNALD. Slightly enlarged.



Figs. 5 a. *Galium brevipes*, part of stem showing spines, drawn from type specimen, Grand River, Gaspé County, Québec. b Fruits of the same.

brevipes rather closely approaches that variety. Perhaps it would be best to keep *G. brevipes* as a distinct species until more observations of it can be obtained.

To show the relationships and to facilitate the search for eventual new occurrences, I have annexed an

Analytical Arrangement of the small *Galium*-species of N. Europe, Greenland and N. Atl. America.

I. Corolla tetramerous.

A. Leaves in whorls of 6—8, linear-lanceolate, with distinct mucro, 5—10 mm. long, 1—2 mm. broad. Mature fruits warty, ab. 1 mm. in diam. Erect, 1.5—3 dm. high, retrorse-scabrous, with apical, richly flowered inflorescences. Not blackening when dried.

Wet bogs, meadows and lake-borders in temp.-bor. Europe and Iceland, (not in America).

G. uliginosum L.

Fig.: Fl. D. 1509; Rchb. 1193; Hegi: VI. 1. tab. 248. fig. 4; Lindman: pag. 505.

B. Leaves in whorls of 4, linear-lanceolate to oblanceolate-spatulate, obtuse, without mucro. Fruits glabrous.

a. Inflorescence forming small dichotomous cymes with several flowers, the peduncles of which become gradually horizontally distant. Plant erect, 2—5 dm. high, sparingly branched, retrorse-scabrous, blackening in drying. Leaves 10—12 mm. long, 2—4 mm. broad. Fruits united nearly to the top, 2.5—3.3 mm. in diam.

Wet meadows, temp.-bor. Europe, (not in Iceland), temp.-bor. N. America to Québec and Newfoundland.

G. palustre L.

Fig.: Fl. D. 2764; Rchb. 1185, I; Hegi: VI, 1. tab. 248,3; Lindman: p. 503; Gray Man.: p. 749.

In Europe several varieties are discerned; see f. inst., Neuman & Ahlfvengren p. 107.

b. Flowers in single pairs or in very few-flowered cymes.

α. Leaves normally erect, 15—25 mm. long, faintly scabrous on margins and midribs of lower side. Stem erect, 1—8 dm. high, freely branching from base. Peduncles not horizontally distant. Fruits 2.5—3.5 mm. in diam.

Damp, shaded woods in E. N. America to Québec; (not in Europe).

G. tinctorium L.

Fig.: Gray Man. p. 750.

β. Leaves soon reflexed, 5—15 mm. long, distinctly scabrous on margins and midribs of lower side. Plant erect, 0.5—3 dm. high, from capillary rootstocks. Inflorescence as in the preceding species, flowers rather larger, but fruits much smaller, 1.0—1.5 mm. in diam.

In mossy *Larix*- and *Thuja*-swamps of bor. N. America to S. Labrador; (not in Europe).

G. labradoricum WIEG.

Fig.: Gray Man. p. 750.

II. Corolla trimerous.

A. Stems distinctly retrorse-scabrous.

a. Flaccid and weak, freely branching, often densely matting. Flowers solitary or geminate on capillary, arcuate, 0.5—2 cm. long peduncles. Leaves narrow, linear-lanceolate, often reflexed, their margins and midribs as well as the peduncles retrorse-scabrous. Fruits 1.25—1.50 mm. in diam., only halfway united.

Bogs, mossy woods and wet lake-shores in bor.-subarct. N. America to Labrador, bor.-subarct. N. Europe, Iceland (?), Styria (one locality).

G. trifidum L.

Fig.: Fl. D. 48; Rchb. 1198, II; Hegi: VI. 1. p. 223; Gray Man. p. 750.

b. Stouter, suberect. Flowers in terminal cymes of 2's or 4's, on thick, straight and glabrous peduncles. Leaves spatulate, retrorse-scabrous on margins and midribs.

Swamps and damp places in Pac. N. America, Cordilleras, and E., temp.-bor. N. America to Québec and Newfoundland; (not in Europe).

G. Claytoni MICHX.

Fig.: Gray Man. p. 750.

B. Stems indistinctly scabrous or glabrescent; leaves scabrous on margins and midribs.

a. Flowers solitary or paired, on straight or arcuate, axillary, very slightly prickly peduncles. A glabrescent form of the preceding, more boreal in distribution and especially from brackish and lime-stone localities in E. N. America to S. Labrador.

G. Claytoni var. *subbiflorum* WIEG.

b. Very small, richly branched and densely matted. Flowers solitary or geminate on very short, 0.5—4 mm. long, glabrous, curved peduncles. Fruits very small, 0.8—1.0 mm. in diam.

Wet swamps in Coniferous woods in E. N. America: Minn., Me. and Québec.
G. brevipes FERN. & WIEG.
Fig. nostra 4, 5 b.

C. Stems, peduncles and leaves glabrous.

a. A form of *G. trifidum*, from which it only differs in the glabrous stems, peduncles and leaves. Fruits slightly larger, 1.50—1.75 mm. in diam.

Brackish marshes in E. Atl. N. America, from Me. — Québec.
G. trifidum var. *halophilum* FERN & WIEG.

b. Sparingly branched, suberect, 5—15 cm. high. Flowers lateral, solitary or geminate, on arcuate pedicels, as long or longer than the leaves, (10 mm.). Fruits 1.7—2 mm. in diam.

Springy places and wet moss in New Mexico, alpine; bor.-atl. America: Gaspé, Newfoundland and Labrador; S. Greenland.
G. Brandegeei GRAY.
Fig. nostra 1—3, 5 a.

III.

THE GENUS *ANDROMEDA* IN GREENLAND

During his extensive travels throughout the settled coast of West Greenland, JENS VAHL found no *Andromeda*. The first to report it was J. TAYLOR, surgeon on whaling ships, who states *A. polifolia* for Disco. 69°10′ N. and Wilcox Point 74°18′ N. (Trans. Bot. Soc. Edinb. Vol. VII. Part II, 1862). H. C. HART, botanist on the NARES expedition, claims

Abbreviated titles used in the key.
Fl. D. Icones Florae Daniae, Hauniae 1761—1880. Not seen.
Rchb. Reichenbach: Icones Florae Germaniae, 1834—67. Not seen.
Gray Man. Robinson & Fernald: The Gray Manual or Handbook of Flowering Plants and Ferns . . . N. U. S. and Canada. 7. 1908.
Hegi: Illustrierte Flora v. Mittel-Europa, Vol. I—VI. not finished.
Lindman: Svensk Fanerogamflora, 2. uppl. 1926.
Neuman & Ahlfvengren: Sveriges Flora, 1901.

to have collected the same species, 1875, on "S. Disko, E. of Godhavn". (Journ. Bot. London 1880). According to H. G. SIMMONS, who studied the plants of TAYLOR and HART in the herbaria of the British Museum, there are, however, no *Andromedas* among them. The identifications must consequently have been erroneous, as was often the case with the said authors. As to the last locality the present writer may remark that, after twenty years of botanizing "E. of Godhavn, S. Disko", he has found no *Andromedas* there.

In 1878, an *Andromeda* was picked up by the geologist A. KORNERUP, at the head of the small fiord Tiningnertôq, 62°20′, just south of the great Frederikshaab glacier. The plant was identified by JOH. LANGE as *A. polifolia* and the specimens were preserved. They were dwarfish, growing in *Sphagnum*, showing barely two years growth overtopping the moss, each year's growth 15—20 mm. long and with 3—4 leaves. Young flowers are present, but no fruits. Later this section of Greenland — not the locality itself — has been investigated by the very experienced collectors L. K. ROSENVINGE and N. HARTZ, but without adding new stations for *Andromeda*.

In 1925 I had made a collecting trip to the southernmost parts of Greenland, accompanied by my son, A. E. PORSILD. On our return we stopped for two hours at the settlement of Neria, 61°33′ N. to visit the native catechist J. EUGENIUS, who for some time has been collecting herbarium specimens for me. In looking over his harvest, we noticed a fine set of a dwarfish *Andromeda*, matching very well the plants of KORNERUP of which I have a small duplicate from LANGE's herbarium. EUGENIUS' plants were taken on moist, boggy ground on the island of Narssalik, 62°38′ N. Since, I have twice got specimens from the same locality.

A week later we arrived at Egedesminde where we met the ornithological expedition of Mr. E. LEHN SCHIØLER, of which Mr. JOHANNES LARSEN, well known to all for his artistic skill and his thorough knowledge of bird-life, was a member. But he is also known to his friends as having a great knowledge of Danish plants. He told me that he had seen an *Andromeda* on the small island of Manitsoq, 68°47′ N. the day before. Mr. LARSEN took no specimens but only wondered why he had not seen that plant before in the different sections of South Greenland the expedition had visited. I rather doubted the identification of his find, as it seemed surprising to me to get two new stations for a genus only found once before, and this station was so far north; so I proposed a few other names, as *Loiseleuria*, *Phyllodoce*, etc. These were unknown to Mr. LARSEN, whereas he would not let himself be saddled with the suspicion of having made a mistake about Andromeda. So we started at once to see the plants in doubt.

Under Mr. LARSEN's guidance we went straight to the plant. It grew between mosses — no *Sphagnum* — in company with *Myrtillus uliginosa*, *Ledum decumbens*, *Betula nana*, species of *Carex* and *Juncus* etc., on morainic soil. The island consists totally of gneiss and granite. The area occupied by the *Andromeda* was barely more than 50 m. across. It was in full flower, on Aug. 22nd, and we found a few fruits from the year before.

In identifying plants from West Greenland it is quite appropriate to look up the status of the species in question in Northern Atlantic America. In regard to *Andromeda*, M. L. FERNALD has shown, (Rhodora 1903, p. 67) that here are two species, viz., the common *A. glaucophylla* Link. and the much rarer *A. polifolia*, restricted to arctic-alpine situations. For the history and nomenclature of *A. glaucophylla* see FERNALD's paper, as well as a later article by the same author in Rhodora 1916, 100. Of the first species, I had a specimen from Nova Scotia (Gray Herbarium N. 24289, leg. M. L. FERNALD and B. LONG.) showing a fruiting shrub 2—3 dm. high with leaves up to 33 mm. in length; thus, in habit and size very different from all the small Greenland specimens. As my partner on the trip, A. E. PORSILD, wanted to leave Greenland to go to America that autumn, I was forced to label our collections of the trip somewhat hurriedly, as he wished to compare some critical plants with the large collections in the Copenhagen herbarium. The *Andromedas* from both of the new localities were thus labelled "*A. polifolia* L." and duplicates with that name issued. At Copenhagen, however, A. E. PORSILD found ample material of *A. glaucophylla*, by which he could prove that the *Andromedas* from all the southern localities in Greenland really belonged to this species, whereas the specimens collected at Manitsoq, six degrees farther north, were *A. polifolia* L. After a renewed investigation of the specimens I quite agree with him.

Before going into detail, I have still to mention that WARMING in his "Biology of Arctic Plants" (Medd. om Grl. 36, p. 29) studied the morphology and biology of the flowers of *A. polifolia*, chiefly on Danish and Norwegian material. He also mentions material from West Greenland, of which he says, in describing the flowers:

"I do not find any important difference between Greenland and European individuals."

As the plants of KORNERUP, at that time, were the only ones known, this statement must refer to those specimens, i. e. herbarium specimens with but few and quite young flowers.

The anatomy of the *Ericales*, in the same work, is given by H. E. PETERSEN (l. c., p. 107, 1917). Dr. PETERSEN made his sections from the KORNERUP plants, labelled by LANGE *A. polifolia* L., and described them in a comparison with what was known about the anatomy of *A. polifolia* in Europe. He probably was not aware that any related species might be taken into consideration. PETERSEN found nothing in the anatomical features which "would serve to discern" arctic specimens from temperate ones, except that he states repeatedly: that the fine pubescence on the lower surface of the Greenland plants does not occur in any European plant. The absence of those hairs on specimens

Fig. 6. a. *A. polifolia;* b. *A. glaucophylla*, slightly enlarged (after FERNALD).

from Arctic Norway might have suggested to the anatomist that he had a specific and no ecologic character before him.

The North American species of *Andromeda* are described by FERNALD (Rhodora 1903, p. 70—71 and Gray Manual 7. edit. 1908, p. 634—35) thus:

A. polifolia. Low shrub, with elongate creeping base; stem simple or with ascending branches, 5—30 cm. high; *leaves linear to narrowly oblong*, either flat or revolute, *glabrous*, generally *whitened beneath with a varnish-like coat, later often green;* bud-scales scarcely glaucous; *pedicels* in terminal umbels, *filiform, straightish 2—4 times exceeding the nodding flower and erect fruit;* corolla pink or white; calyx with pale or usually reddish slightly ascending lobes; *capsule brown or reddish*, obovoid or subglobose, *as high as broad.*

A. glaucophylla Link. Similar in habit; *leaves white beneath with close fine pubescence;* branchlets and *bud-scales glaucous; flowers on thickish curved pedicels rarely twice their length;* calyx-lobes whitish, usually spreading; *capsule depressed, turban-shaped, glaucous.*

The Greenland specimens of *A. polifolia* L. have all leading characters in common with the description above, but the plants are very small. The stems are freely branching in the mosses or humus of decayed

leaves and provided with fine-branched and mycotrophic roots right up to the lowermost leaves. Only the tops of the branches are visible above the "soil", they are hardly over 1 cm. long, with very short internodes, bearing 6—10 leaves, and an inflorescence with 3—5 flowers. The leaves are 8—11 mm. long, 1—1.5 mm. broad, in rare cases shorter and broader. The pedicels are 10—15 mm. long, the flowers overtopping the uppermost leaves. The plant when in flower is quite conspicuous, but without, it would easily be overlooked. Even in this dwarfish state, the inflorescence is characteristic of the species, as is the waxy coat and the total absence of hair on the lower surface of the leaf. Also in Europe dwarfed forms are mentioned from extreme localities, f. inst., var. *acerosa* Hartm., but they are probably forms of no taxonomic value.

Fig. 7. a. *A. polifolia* from West Greenland, 68°47′ N., with young fruits, Aug. 22nd, 1925 leg. JOHANNES LARSEN; b. *A. glaucophylla* from West Greenland, 61°22′ N., Aug. 2nd, 1925, leg. J. EUGENIUS.

As already stated the Greenland specimens of *A. glaucophylla* Link are likewise, dwarfish, even more than its calciphile variety, *iodandra* Fern. (Rhodora 1916, 100). The tips of the branches overtopping the moss or the soil are from 1.5—3.5 cm. long, bearing from 8—25 leaves on shortened internodes. The mature leaves are 10—18 mm. long and are very involute; in most cases the involute parts of the blade are closely pressed to the midrib. Therefore it is often difficult to see the hairs on the lower surface, as there are none on the whitish midrib. The hairs (fig. 8) are short, one-celled, hyaline, and divergent, forming a very fine and close, but thin, tomentum. They are barely visible under a strong lens, but easily seen in sections under the microscope. The hairs alone are sufficient for discerning the species. But in the dwarfish state, too, the inflorescence is quite characteristic with its short

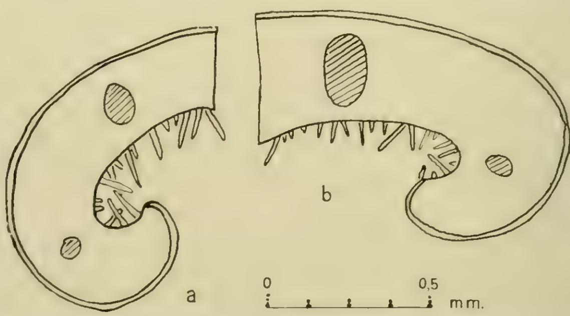


Fig. 8. Sections of the leaves of *A. glaucophylla*, showing the hairs on the lower surface; a. typical form from Newfoundland; b. from West Greenland.

and thick pedicels, and its tendency to become (see fig. 7) spirally bent. The flowers of the Greenland plants are not oblate subglobose, like the var. *iodandra*, but distinctly urceolate, light pinkish, distinctly paler than in Greenland forms of *A. polifolia*. Anthers — in herbarium specimens — are brownish, but not pale-brown as is said about the main form.

I have not yet seen mature fruits, but only found a very few old ones, showing that the plant fruits in Greenland, at least in favourable seasons.

Besides the differences given by FERNALD and quoted above, there seems to be yet another. In *A. polifolia*, as it is described from Europe and as specimens at hand from Europe and Alaska show, the stems are very richly provided with roots, arising as WARMING l. c. has shown, in the axils of the leaves. The Greenland specimens are root-bearing right up to the lowermost leaves. The Greenland specimens of *A. glaucophylla* do have roots on the subterranean parts of the stems, but in markedly less degree, and in two herbarium sheets from America there are none at all. One sheet (Gray Herbarium Nr. 24289, from Sphagnous boggy swale bordering a lake in Nova Scotia) shows stems without a single root, measuring 21—25 cm. up to the lowermost leaf. In the other (Gray Herbarium Nr. 26926, from turfy and peaty knolls in limestone barrens in New Foundland, leg. M. L. FERNALD, B. LONG, and B. H. DUNBAR) there are none either. The bare parts of the stems under the lowermost leaves are 3—6 cm. long. These last specimens are without flowers, but probably belong to the variety *iodandra*, as the habit matches well with the description and as they came from the same region and kind of soil as the variety.

The geographical Distribution of the Species.

In America *A. polifolia* is generally considered an arctic plant, extending very locally south to the Adirondack Mountains, Lake Huron and southern Alaska. Mostly the floras give the distribution quite broadly: "from the Atlantic to the Pacific and to the Arctic Ocean". From literature available here a few really arctic occurrences may be mentioned: the Atlantic coast of Labrador, Kotzebue Sound and St. Lawrence Island, to which may now be added West Greenland, in 68°47′ N. But in Eurasia this species cannot correctly be labelled arctic. Generally speaking, in Europe and Asia it occupies the northern belt of Coniferous woods and most of the deciduous forest regions. Southwards, it stops when the steppe-belt begins, or it is only to be met with in isolated alpine or boggy situations, see, f. inst., BRAUN-BLANQUET in his treatment of the Ericales in HEGI: Illustr. Flora von Mittel-

europa vol. V. 3, p. 1652, where he states the occurrence to be coincident with that of *Trientalis europaea*, for which a map is given in the same volume p. 1862. Northward, it stops where the forest stops and the tundra begins. At its northern limit it is a lowland plant, in Norway only ascending to low or moderate altitudes (Norman), and only on the most favourable points it reaches high latitudes, f. inst., in Norway and in the Lena valley, up to 71° N. If, indeed, the climatic requirements of the American and Eurasian stock of *A. polifolia* are different, a renewed investigation of their identity might be appropriate. The arctic *Andromeda* of America may, with the Greenland plant, constitute an undiscerned form, making *Andromeda* analogous to such species as *Vaccinium Vitis Idæa* of which Greenland and America have only the variety *pumilum*, or of *Saxifraga comosa*, the nearest relative of which *S. stellaris* is in Europe and South Greenland, but not in America.

For *A. glaucophylla*, Fernald, l. c., gives the distribution: Ailik Bay 55° N. in Labrador, west to Lake Winnipeg, south to Minnesota, Pennsylvania and Northern New Jersey. A remarkable extension is Southwest Greenland 62°20′—38′ N., but it has a great number of parallels, f. inst., *Carex pratensis*, *Streptopus amplexifolius*, *Orchis rotundifolia*, *Anemone Richardsoni* and some 30 others. It seems easiest to interpret the small and isolated *Andromeda* occurrences in Greenland as the dwindling remainder of a more genial postglacial optimum-climate when probably the areas were much larger.

IV.

THE GREENLAND CRANBERRY.

In the southern part of West-Greenland, from the Godthaab Fiord region, in 64°32′ N., and down to the southernmost point, a cranberry is quite common. By J. Vahl, in his printed labels, and by Joh. Lange, in his "Conspectus Fl. Grl.", 1880, p. 90, it was simply called *Oxycoccus palustris* Pers., but A. Berlin identified plants collected by himself as *O. palustris *microcarpus* Turcz., and claimed this subspecies to be new to the Greenland flora (Öfv. K. Vet. Ak. Förh. Stockholm 1884, Nr. 7,

p. 53). However, BERLIN's specimens were all sterile and his identification therefore not very well founded. The name has later been used by HESSELMAN who investigated the mycorrhiza on BERLIN's specimens (Bih. K. Sv. V. Ak. Handl. Stockh. B. 26, Afd. III, Nr. 2, p. 27).

LANGE took up BERLIN's localities in the appendix to his Conspectus, 1887, p. 267, but did not recognize BERLIN's identifications. But instead, LANGE named the Greenland plants "f. *microphylla*",

foliis plerisque quam in forma typica minoribus; pedunculis puberulis",

and adds, p. 268:

Foliis saepius minutis nonnihil accedit ad var. *microcarpam* (TURCZ.) cui tamen propter pedunculos pubescentes adnumerari non potest. Foliorum magnitudo ceterum, bene observantibus cll. BERLIN et WARMING, variabilis est, quare potius forma borealis quam varietas constans habenda est.

By L. K. ROSENVINGE in his second appendix to the "Conspectus", 1892, p. 692, the name *microphylla* LANGE is also dropped with the remarks:

Pedunculi semper puberuli. Folia plerumque minora quam in forma typica (f. *microphylla* LGE.) ceterum haud diversa. Forma typica haud raro in locis fertilioribus invenitur, formis intermediis cum f. *microphylla* conjuncta.

Oxycoccus microcarpus TURCZ. was probably founded on specimens from the Baical-Dahurian region in Siberia. The species has since been kept separate by nearly all Russian authors. In European floras it appeared sometimes as a variety, sometimes as a subspecies, or, it was entirely neglected, but in the latest and most modern Scandinavian floras, f. inst., NEUMAN & AHLFVENGREN, LINDMAN, HJELT, etc., it has, based on closer researches in the field, been given full specific value. Quite recently G. SAMUELSSON, in revising the Swiss herbaria, also found the species quite common in the European Alps. About its taxonomic status he says (Vierteljahrschr. Naturf. Ges. Zürich 67, 1922, p. 256):

Oxycoccus quadripetalus ist bekanntlich eine ziemlich polymorphe Art. Ihre Abgrenzung gegen *O. microcarpus* macht jedoch selten Schwierigkeiten. Das am leichtesten fassbare Merkmal von *O. microcarpus* liefert der kahle (oder fast kahle) Blütenstiel, (bei *O. quadripetalus* deutlich behaart!). Die Kleinheit aller Teile, wie Blätter, Blüten, Früchte usw., ist gewöhnlich sehr auffallend. Die Blattform ist auch dadurch etwas abweichend, dass die Blätter ihre grösste Breite fast an der Basis haben und ausgeprägter zugespitzt sind. Die Blüten haben eine gewöhnlich stärker rote Farbe, und die Früchte sind deutlich verlängert (birnen- oder zitronenförmig). Blütezeit und Fruchtreife fallen ein bis zwei Wochen früher als bei *O. quadripetalus*. Zusammen sind diese Merkmale hinreichend, um *O. microcarpus* als eine gute systematische Einheit zu bezeichnen.

Besides the characters mentioned above, there are several of less value, because they seem to be less constant, viz.:

O. quadripetalus Gil. (= *O. paluster* Pers.)		*O. microcarpus* Turcz.
several	flower-stalks	single or in pairs
pubescent	bracts	glabrous
ciliate	calyx-lobes	glabrous
pubescent on edges, naked on outer side	filaments	pubescent all over
longer than the tubes or filaments.	anthers	shorter than the tubes or filaments.

It is of far more importance, however, as also Samuelsson emphasizes, that the two species are ecologically different. According to E. Melin, ("Studier över de Norrländska Myrmarkernas Vegetation", etc. Uppsala 1917, p. 124 ff.), *O. microcarpus* is bound to a certain, well-defined association of species having *Sphagnum fuscum* and a few other xerophilous species of *Sphagnum* as its substratum. *O. microcarpus* is thus what Braun-Blanquet[1]) calls "gesellschaftstreu" (in French: "exclusif"), whereas *O. quadripetalus* is at most "gesellschaftshold" (préférant), or even "gesellschaftsvag" ("indifférent"), as it grows on several, ecologically widely different species of *Sphagnum*, as well as on *Hypnaceae* or other substrata.

Plants with some of the characters verging towards *O. quadripetalus* have sometimes been supposed to be hybrids, but Samuelsson states (l. c.) that actual hybrids are very rare:

> Obgleich ich beide hundertmal gesehen habe, so bin ich in der Natur nur einmal auf eine wahrhaft kritische "Zwischenform", und zwar betreffs aller oben besprochenen Merkmale, gestossen, und sie kam tasächlich mit beiden Arten zusammen vor, weshalb ihre Bastardnatur sehr wahrscheinlich ist.

O. microcarpus Turcz. is quite common in Northern Europe, from Iceland to Russia, also in the Alps, and in Northern Asia to Sachalin. From America, I have not seen it reported, but a specimen from Wrangel, Alaska, collected by Fr. V. Coville and Th. H. Kearney (Harriman Expedition Nr. 436) undoubtedly belongs here. In well-investigated countries, as the Scandinavian peninsula and Finland, *O. microcarpus* evidently ranges somewhat farther north and to higher altitudes than *O. quadripetalus*.

[1]) For the explanation of these terms see f. inst., Braun-Blanquet: Prinzipien einer Systematik der Pflanzengesellschaften auf floristischer Grundlage. Jahrb. St. Gall. Naturh. Ges. 57. II. 1921 and E. Ruebel: Ueber die Entwicklung der Gesellschaftsmorphologie. Journ. of Ecology 8. 1920, where numerous other papers on this subject are mentioned.

Students of the flower-biology of *O. quadripetalus* (Sprengel, Kerner, Lindman, Warming, Kirchner)[1] do not think that self-pollination ever takes place in this species. The flower is slightly protandrous and the style is elongated, so that the mature stigma is well removed from the anther-tubes. The dry pollen-tetrads will easily drop out, but owing to the position of the expanded flower they do not touch the stigma until a humble-bee attaches itself to the flower, and by its weight bends it vertically downwards. Other insects are said to be unable to effect pollination.

The flower-biology of the *Oxycoccus* from Greenland and Arctic Norway has been investigated by Warming (Biol. of. Arct. Pl. vol. I, p. 54. Medd. om Grl. 36, 1912). He had evidently also material of *O. microcarpus*, but he did not recognize the difference between this species and the Greenland plant.[2] Warming found that in the flowers of the northern cranberries the anthers were already open and shedding pollen in the bud, as has been observed in many other Arctic *Ericaceae*. Further, the style in the mature state barely overtops the anther-tubes and he thinks that, in the northern plants, self-pollination regularly takes place. This statement of the length of style fits best with *O. microcarpus*. The flowers of the Greenland plant, as seen by the present writer, are fully expanded, with the corolla fully reflexed before the style even protrudes between the anther-tubes, and overtopping stigmas are only seen when the flowers begin to wither.

Thus the northern forms of the cranberries may, genetically, become pure lines.

The Greenland plant. Having before me numerous specimens of 16 different collections and notes from others, kept in the Copenhagen herbarium, I cannot subscribe to the statement by Rosenvinge, quoted above, that also typical *O. quadripetalus* occurs in Greenland. To me, they represent a very uniform type which, in brief, can be characterized as different from *O. quadripetalus* in all its dimensional characters, as well as in the colour and biology of its flowers. With *O. microcarpus*, it has the dimensions in common, but it differs in the fruits and the flower-stalks being even more pubescent than in the type. If typical *O. quadripetalus* did really exist in Greenland, a designation of the dwarfish state as a "forma" would be fitting. As it is now, it seems

[1] See: Kirchner, Loew u. Schroeter: Lebensgeschichte der Blütenpflanzen Mitteleuropas. Lief. 23—24. Stuttgart 1923, p. 124.

[2] On p. 56 is an obvious "lapsus calami" when W. ascribes "downy" instead of glabrous pedicels to *O. microcarpus*.

more appropriate to consider it a local variety, fixed genetically, and hence I propose as its name:

O. quadripetalus GILIB., var. *microphyllus* (LANGE) n. c.

It differs from the main form chiefly in its dimensions: free, leaf-bearing shoots, generally 2—3 cm., only exceptionally (when not growing on *Sphagnum*) up to 2 dm. long. Leaves with strongly revolute margins (more than in the type) (3—)4—5(—7) mm. long, 2—2.5 mm. broad, elliptic-ovate. (In *O. microcarpus* the leaves are nearly of the same size but different in form, being distinctly broadest near the base and more pointed). Peduncles single, rarely in pairs, brownish-red, (10—)12—15 (—18) mm. long, densely covered by short whitish hairs, especially upwards, nearly as dense as in *O. macrocarpus* PURSH. Calyx-lobes with red margins, finally entirely red, faintly ciliate, at the top depressed and in the median line apiculate. (WARMING l. c., fig. 96 D). (In the type they are evenly rounded-obtuse (WARMING l. c., fig. 37 A), often green throughout). Flowers about half the size of the type, equalling those of *O. microcarpus*. Petals deep red, (in *O. quadripetalus* whitish with a not well-defined pink midline; in *O. microcarpus* this line is deeper coloured and sharper defined). Filaments dark chocolate, pubescent on margins. Anthers brown, glabrous, tubes slightly longer than the anthers, shiny, golden-bronze-coloured. Style red, in the expanded flower shorter than the tubes but finally barely overtopping them. Berries deep red (like those of *Vaccinium Vitis Idaea*, v. *pumilum*), always globular, ab. 5 mm. in diameter.

V.

RANUNCULUS PYGMÆUS WAHL. VAR. *LANGEANA* NATH.

From alpine situations in Gaspé County, Québec, M. L. FERNALD has described (Rhodora 1917, p. 137) a peculiar variety of *R. pygmaeus* which is called var. *petiolulatus* n. var.

foliis radicalibus pedatim divisis, foliolis 3 petiolulatis rhomboideo-obovatis palmatis laciniis 3—5 oblongis vel valde divisis; capitulis fructiferis 5—7.5 mm. longis

In its basal leaves the new variety is said to be quite like the rare Rocky Mountain species, *R. Grayi* BRITTON, but differing in the floral parts. And in FERNALD's recent work: "Persistence of Plants in Unglaciated Areas, etc.", Mem. Am. Ac. Sc. 15. III, 1925, p. 299, the plant is considered a strict endemic, characterizing the unglaciated summits of the region mentioned.

This plant is, however, also known from Greenland, where it was detected by A. G. NATHORST, 1883, at Unartuarssuk on the east coast of Disko, and described under the name of *R. pygmaeus* var. **Langeana*, (Öfv. K. Vet. Ak. Förh. 1884, N. 1, p. 46), and good photographs were given in the annexed plate. LANGE included the plant in his Conspectus Florae Groenlandicae, pars II. 1887, p. 254, and translated NATHORST's original Swedish description into Latin:

1—4" alta, caespitosa, foliis radicalibus trisectis, segmentis magis minusve longe petiolatis, sursum latioribus, intermedio saepius 3—4-fido, lateralibus 2—4 fidis, foliis caulinis subsessilibus, ad basin usque 3—5-fidis, laciniis laceolatis v. sublinearibus

The plant was found again, in 1890, by N. HARTZ at Qutdligssat 70°3′ N., and several other places on East Disko, (Medd. om Grl. 15, 1894, p. 52), and by the present writer at its type locality in 1898 and later. It also occurs on West Disko in Mellemfiord at Kuánit, 69 45′ N., (M. P. P.), and at Qasigigssat, 69°52′ N., (A. E. P.).

On the eastern coast of Greenland var. *Langeana* has been mentioned by HARTZ and KRUUSE (Medd. om Grl. 18, p. 331, 1895 and ibd. 30, p. 167, 1905) from three localities lying between 70 30′ and 71°40′ N. All Greenland localities, so far, are in the sedimentary sections of Greenland, not in the Archean.

In spite of the widely different shape of the leaves NATHORST doubted that his plant was a separate species, as in typical *R. pygmaeus*, too, the basal leaves show some tendecy to become more deeply cleft. This doubt was emphasized by HARTZ and KRUUSE who state that the var. *Langeana* is connected with the main form by intermediate forms. HARTZ, especially, mentions such forms from Ritenbenk, in W. Greenland, 69 44′ N., which is in the gneissic area. And a similar statement has been made by myself (Medd. om Grl. 50, p. 375, 1912) from plants collected in W. Greenland, 71°—73° N., in the gneissic area. My statement, however, was a mistake; the plants in question are only somewhat luxuriant forms of typical *R. pygmaeus*. Having at present no access to the specimens of HARTZ or KRUUSE, I must for the subsequent remarks be contented with my own observations from Disko.

Lastly, K. JESSEN has made an elaborate study of the morphology, anatomy and biology of the arctic *Ranunculaceae* in Medd. om Grl. 36,

p. 383, 1912. Here the variety is also mentioned, but new facts regarding its taxonomic position were not brought forward.

Compared with *R. pygmaeus*, the var. *Langeana* NATH. is less tufted, the stems are slender erect, 10—15 cm. high, mostly with two stem leaves. Typical *R. pygmaeus* is densely tufted, more or less prostrate — ascending, but, when growing in moss, the stems become longer, 10—12 cm. The leaves are distinctly lighter-coloured and a trifle thinner. JESSEN gives the average thickness of the leaves of *R. pygmaeus* as 0.27—0.30 mm., whereas sections of the variety *Langeana*, made by me, averaged 0.22 mm. in thickness. The anatomy of the leaves and the disposition of the stomata are practically the same. Also in var. *Langeana*, the roots are mycotrophic. NATHORST suggests that the pedicels of the variety seem to be more pubescent than in the typical form, but I have not been able to find any difference when they were of equal maturity. The achenes are practically equal in size and shape. Generally, however, the styles of var. *Langeana* are straight or nearly so, whereas the styles of *R. pygmaeus* are distinctly recurved (see JESSEN l. c., p. 382, WAHLENBERG Fl. Lapp., tab. VIII), but straightish styles are also sometimes seen in this species.

In spite of the slight difference, except in the form of the leaves, var. *Langeana* NATH. seems not to be a mere ecologic form, but rather a geographical race, hitherto known from Greenland and alpine Gaspé, Québec. If it were only a form adapted to growth amongst mosses, it would certainly have been noticed long ago in Northern Scandinavia, where *R. pygmaeus* has been known for nearly 200 years; and then one should easily find it everywhere. But such is not the case, here at least. On many suitable spots it has been searched for in vain, whereas at its type locality, where also typical *R. pygmaeus* is abundant, it is always easily found.

BIANCO LUNO A/S, KBHVN

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **X**, 2.

THE REPRODUCTION OF AHNFELTIA PLICATA

BY

L. KOLDERUP ROSENVINGE

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI A/S
1931

Meddelelser fra den botaniske Have i København. Nr. [illegible]

Det Kgl. Danske Videnskabernes Selskabs videnskabelige Meddelelser udkommer fra 1917 indtil videre i følgende Rækker:

Historisk-filologiske Meddelelser,
Filosofiske Meddelelser,
Mathematisk-fysiske Meddelelser,
Biologiske Meddelelser.

Hele Bind af disse Rækker sælges 25 pCt. billigere end Summen af Bogladepriserne for de enkelte Hefter.

Selskabets Hovedkommissionær er *Andr. Fred. Høst & Søn*, Kgl. Hof-Boghandel, København.

Det Kgl. Danske Videnskabernes Selskab.
Biologiske Meddelelser. **X**, 2.

THE REPRODUCTION OF AHNFELTIA PLICATA

BY

L. KOLDERUP ROSENVINGE

KØBENHAVN
HOVEDKOMMISSIONÆR: ANDR. FRED. HØST & SØN, KGL. HOF-BOGHANDEL
BIANCO LUNOS BOGTRYKKERI A/S
1931

Arbejder fra den botaniske Have i København. Nr. 119.

1. Introduction.

The relationship and delimitation of the genus *Ahnfeltia* have always been and are still very uncertain. The genus was first given a tolerably natural delimitation by J. G. AGARDH who distinguished it from the genus *Gymnogongrus* near which it was placed (comp. Spec. g. o. II, 1851, p. 310). In his Epicrisis (Sp. g. o. III, 1876, p. 205) this author gives the genus the same position and refers to it 6 species which he divides into three sections: *Ahnfeltia*, *Dictyogenia* and *Dianæma*, distinguished by differences in the anatomical structure of the frond. Nemathecia and cystocarps are mentioned or shortly and incompletely described in some of these species, but two kinds of reproduction are never recorded in the same species, and it is therefore doubtful whether all these species really belong to the same genus, even when taking into consideration the anatomical differences mentioned above. SCHMITZ in his paper on *Actinococcus* (1894, p. 396, see also SCHMITZ and HAUPTFLEISCH in ENGLER u. PRANTL 1896, p. 366) took the genus in a narrower sense, comprising only J. AGARDH's section *Ahnfeltia*, while he maintained that the other two sections must be united with *Gymnogongrus*. According to SCHMITZ, not con-

Fig. 1. *Ahnfeltia plicata*. End of frond with nemathecia. December. $2^1/_2 : 1$.

sidering the nemathecia, no organs of reproduction are known in the genus as founded by Schmitz; sex organs and cystocarps are entirely unknown. I can confirm this for the common European species *A. plicata* (Huds.) Fries of which I have examined numerous specimens from the Danish waters gathered in all seasons without detecting any trace of reproductive organs besides the nemathecia. As the nemathecia have no parallel within the Florideæ and as they have been variously interpreted, a closer examination of their structure and development is needed.

2. Earlier Investigations on the nemathecia.

The nemathecia of *Ahnfeltia plicata* seem to have been early observed, but it cannot always be seen from the short descriptions of the earlier authors whether the tubercles mentioned by them refer to the nemathecia or to the frequently occurring warts of vegetative character. The lowermost tubercle depicted in English Botany tab. 1089 (1803) agrees well with the nemathecia and undoubtedly represents such an organ. Lyngbye mentions (1819, p. 42) that the tubercles are in particular met with in spring, which is in good accordance with the behaviour of the true nemathecia; he did not observe any spores. C. Agardh (1822, p. 313) names them nemathecia and states that they are composed of articulate filaments. The following authors (Greville, Harvey, J. Agardh) confirm that and declare that they have not observed any spores, especially no tetraspores. Kützing (Tab. phyc. **19**, tab. 66) pictures a section through a nemathecium and, more enlarged, the radiating filaments, which are said to be composed of "Kettensporen". They are represented as long rows of very small oblong cells of

equal size, but these cells are not the spores. These were first described in 1893 by BUFFHAM and SCHMITZ, who found that the nemathecial filaments produce at the end each a sporangium which gives rise to one monospore.

BUFFHAM observed the escaping monospores which were ellipsoid, about 15 μ long, and 7 μ thick, thus much larger than the cells of the nemathecial filaments. He gives good figures of these organs (1893, figs. 43, 44). As cited by BUFFHAM from a letter from BORNET, this prominent French algologist had observed such spores as early as 1857. SCHMITZ's observations on the spores agreed with those of BUFFHAM, but he also studied the structure of the nemathecia of this and the related species *A. setacea*, and arrived at the conclusion that the nemathecia were not organs of the *Ahnfeltia* but that they belonged to a parasite, which he called *Sterrocolax decipiens*, growing on the surface of *Ahnfeltia* and penetrating into the cortex of the latter with numerous "Senker". The author admits, however, that the phenomena here described, which he had observed most distinctly in *A. setacea*, were not easy to observe in *A. plicata*. SCHMITZ's inference as to the parasitical character of the nemathecia was only founded on the presence of the said processes penetrating into the cortex, and not on the study of the development of the nemathecia. His inference is, therefore, not conclusive, for the processes might also be explained as secondary formations developed from the base of the nemathecium produced by the *Ahnfeltia*. If the nemathecia were not organs of *Ahnfeltia*, it must be concluded that no kind of reproductive organs had ever been observed in these Algæ. SCHMITZ indeed draws this conclusion for the whole genus *Ahnfeltia* (1894, p. 397, 1896, p. 366), but this is *a priori* highly improbable, in

particular for *Ahnfeltia plicata* which has been so often examined and is of such common occurrence and so easily propagated though it has no vegetative means of propagation. For the elucidation of this question I have examined 1) the development of the nemathecia and 2) the germination of the spores.

3. Development of the nemathecia.

At the coasts of Denmark the nemathecia arise in September. They are not of parasitical origin but appear as

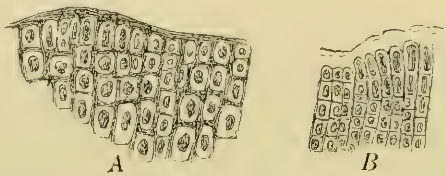


Fig. 2. First origin of nemathecia. September. 670 : 1.

small low cushions arising from a group of superficial cells growing out simultaneously and dividing by cross walls (fig. 2). In September I found the cushions very low, only 1—2 cells high. In the middle of October they reach a considerably larger size (fig. 3). The extension may be up to $^1/_3$ of the circumference of the frond, and this extension is accomplished by the continued production of new nemathecial filaments at the margin. The cells of the nemathecial filaments are longer than those of the cortical layer, usually 2 to 3 times as long as broad and thinner, often only 2 to 3 μ thick; the limit between the cortex and the nemathecium is, however, not always distinct. At the border of the nemathecium the filaments are shorter and bent somewhat outwards. The cells all contain one nucleus; the end-

cells are scarcely different from the others except that they are richer in protoplasm.

At this period two kinds of cells different from the others appear in the nemathecial filaments. Some cells terminal on radiating cell-rows, usually directly on cortical cell-rows, become flask-shaped, being attenuated upwards,

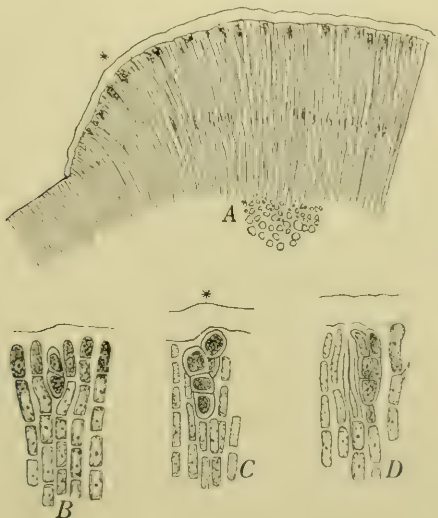


Fig. 3. Nemathecium, October. *A*, vertical section. 244 : 1. *B—D*, upper ends of nemathecial filaments with generative cells. 670 : 1.

thus reminding one of carpogonia and like these staining deeply with hæmatoxylin, but their content is homogeneous and the nucleus is usually not or scarcely visible. They often appear in great number at the bottom of the nemathecium, arresting the growth of the filaments on which they are terminal (figs. 3 and 4); but they are also to be found at higher levels, even near the surface, I have, however, never seen them protruding above the surface. Only in one case, in a wart from a plant having grown in an aquarium from

May to October, I found numerous similar carpogonium-like cells terminal on most of the filaments of the wart,

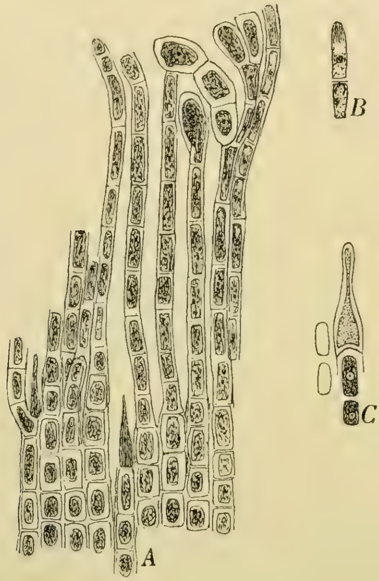


Fig. 4. Nemathecium, October. *A*, vertical section of nemathecial filaments showing flask-shaped cells below and generative cells above. *B*, upper end of primary nemathecial filament. *C*, flask-shaped cell. 1080 : 1.

in several cases protruding above the surface (fig. 5). In some of them a small nucleus was found in the lower or

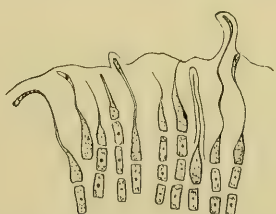


Fig. 5. Vertical section of cushion (anomalous nemathecium?) arisen in a plant kept in an aquarium from May to October. 860 : 1.

in the upper part of the cell. These cells might better be considered as sterile hair-cells though such hairs have not

been met with on the fronds. Hyaline hairs have certainly been observed in the young disc-shaped germlings (see below p. 20, fig. 17), but they were long and had the typical cylindrical shape, not being attenuated upwards. It

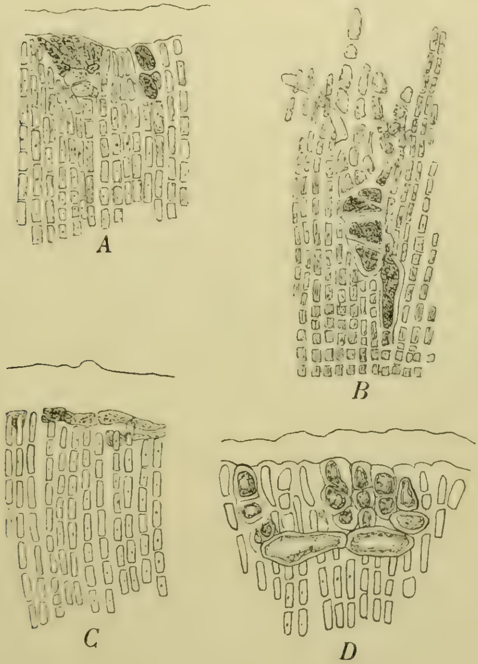


Fig. 6. Vertical sections of nemathecia, October, showing groups of generative cells and horizontal or obliquely upward growing cell-rows springing from them. 625 : 1. The group of generative cells in fig. *B* is situated at the boundary between the nemathecium and the cortex.

is doubtful whether this wart was a nemathecium or only a sterile wart; at all events it was not normal, but degenerated in the middle. The first described included carpogonium-like cells may perhaps also be considered sterile, undeveloped hair-cells. The fact that they are never borne on particular cells comparable to carpogonial filaments but

always situated at the end of ordinary nemathecial filaments or cortical cell-rows, and the absence of a well developed nucleus make it highly improbable that they should be comparable with carpogones.

The other kind of cells differ by their greater thickness and by richer contents. They arise at the upper end of the nemathecial filaments, terminal or lateral, singly or usually in small groups which seem to arise by division

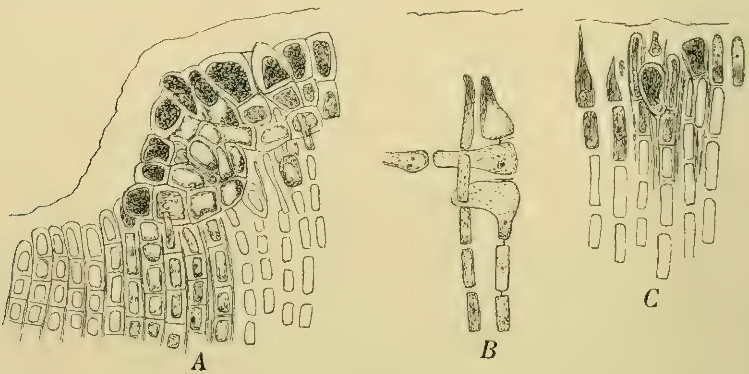


Fig. 7. From a nemathecium, October. *A*, vertical section of the border; the outer portion of the nemathecium is built up entirely of generative cells and their derivates. *B*, generative cells giving rise to horizontal cell-rows. *C*, generative and flask-shaped cells. *A* 960 : 1. *B* and *C* 1080 : 1.

of a single cell. They have the character of g e n e r a t i v e c e l l s. Some of them, at least, grow out, in particular in a horizontal direction, between the nemathecial filaments, where their course may be rather irregular. The cells of these filaments are much larger than those of the nemathecial filaments and they become poorer in contents and therefore often rather hyaline. Fig. 6 shows a horizontal filament running just within the cuticle, and fig. 7 the border of a nemathecium the outer portion of which is exclusively composed of large cells of the same origin. In

fig. 6 *B* is shown a group of generative cells, situated at a low level in the nemathecium, at the limit towards the cortex, from the upper cells of which group new branched cell-rows growing obliquely upwards are produced; these cell-rows are thicker than the nemathecial filaments between which they penetrate.

In specimens collected in the middle of November the nemathecia had grown thicker and had also increased in circumference, the marginal part growing along the surface

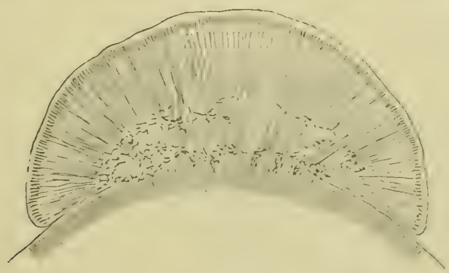


Fig. 8. Vertical section of nemathecium, November. 160 : 1.

of the frond from the insertion of the nemathecium, and the nemathecial filaments being here directed outwards. The outermost (lowermost) filaments are close to the surface of the cortex but not coalescent with it, and the cuticle of the frond remains easily discernible (fig. 8). No connections between the nemathecial and the cortical cells take place here. The large generative cells found in October are found again in the lower portion of the cushion, partly immediately over the limit towards the cortex, partly at a somewhat higher level. They are easily recognisable by their greater size, their irregular shape, their dense cell-contents and their high staining power with haematoxylin. A lively development of cell-filaments like that shown in fig. 6 *B* has taken place, a great number of upward growing

cell-rows issuing from them. It seems probable to me that all or nearly all the cell-rows situated over the large cells in figs. 9 and 10 have been produced by these cells. These cell-rows resemble the primary nemathecial filaments but are at any rate at first thicker than the latter; they form new nemathecial filaments, continuing their way towards the sur-

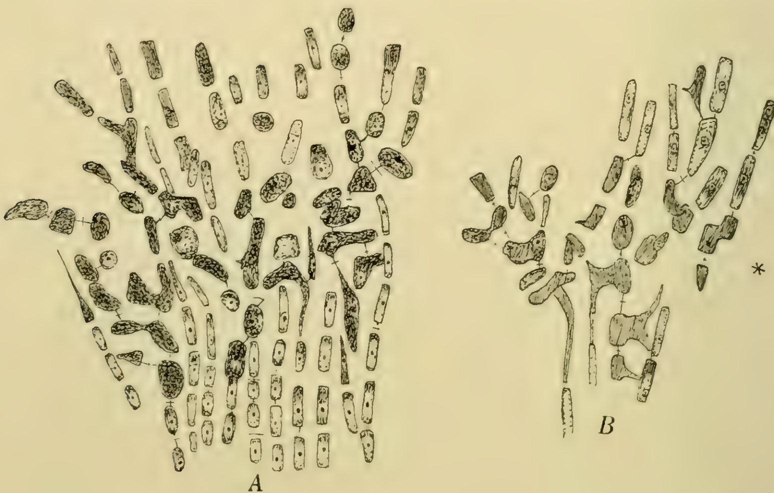


Fig. 9. Vertical section of lowermost part of nemathecium, November. The irregular cells rich in plasmatic contents are situated at the level of the surface of the frond *. 1080 : 1.

face of the nemathecium. The content of the generative cells is homogeneous and stains intensely by hæmatoxylin, but the nucleus is usually not very distinct or scarcely visible. The irregular shape of the cells depends partly on the fact that fusions often take place between cells of different cell-rows. The "Senker" mentioned and figured by Schmitz (l. c. p. 393 fig. 11 and 12) and interpreted by this author as haustoria penetrating from the supposed parasite into the host plant, are undoubtedly groups of the here described generative cells. The obconical shape of

these groups of cells, in particular of those situated at the lowermost level of the nemathecia (figs. 6, 8, 9), is the same as that of the "Senker".

The marginal portion of the nemathecium is composed of horizontal cell-rows not connected with the cortex; these cell-rows have probably all taken their origin from the generative cells or their derivates, like those shown in fig.

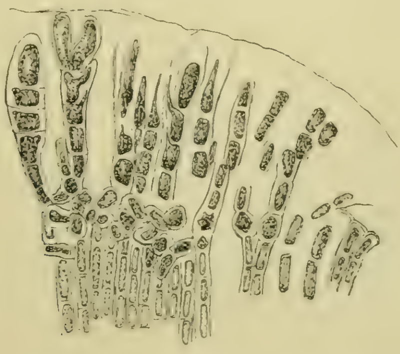


Fig. 10. Vertical section of nemathecium, near the border, December. 670 : 1.

7 *A*, and they must therefore be considered as secondary nemathecial filaments.

The development of the primary nemathecial filaments is, at all events to a great extent, stopped by the formations of the flask-shaped cells and the appearance and further development of the just described generative cells, and they are then replaced by the secondary nemathecial filaments produced by the latter. This arresting seems not only to be caused by the fact that the uppermost cells of the filament have developed into flask-shaped cells or generative cells, for the growth of other filaments also seems to be checked without producing generative cells. On the other hand, primary filaments seem in

some cases to continue their way to the surface of the nemathecium without any connection with the generative cells, e. g. fig. 16 *E*. That, however, is a point that deserves further investigation. Fig. 10 drawn from a specimen gathered at the end of December favours the view that the nemathecial filaments situated over the generative cells are only or principally produced from them.

The narrow cells of the secondary nemathecial filaments

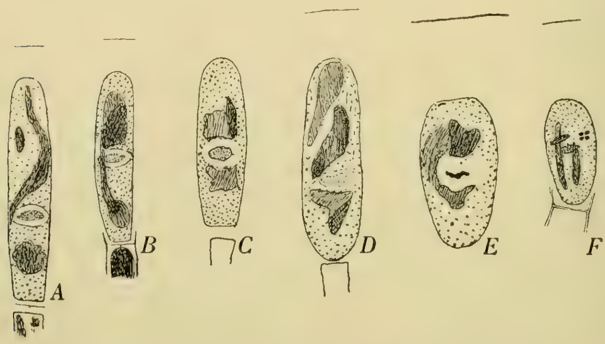


Fig. 11. From a nemathecium from Kerteminde, November (Flemming, Heidenhain). End-cells of (secondary) nemathecial filaments showing nucleus and chromatophores. The nucleus in *A*—*D* has a feebly stained homogeneous central body surrounded by a well limited halo. In *E* the substance of the nucleus is more condensed but shows no distinct chromosomes. In *F* the limitation of the nucleus is indistinct, a group of 4 chromosomes is situated to the right of the central body. 1800 : 1.

contain a small nucleus and one or more chromatophores. The apical cell has more plasmatic contents and a larger nucleus situated in the middle of the cell; it is at first not or scarcely thicker than the others, especially when the cell is still dividing (fig. 14 *A*, *F*, 15 *B*). Later on, when the apical cell gradually develops into a monosporangium, it takes an oblong, ovate or obovate shape. Ripe or nearly ripe spores may occur already in November, but the production of spores continues till May. The resting nucleus

of the end-cell has a large nucleolus or central body, globular or usually somewhat depressed. It is homogeneous in structure and stains intensely or, with a high degree of differentiation, more feebly by hæmatoxylin after HEIDENHAIN. The material was fixed in FLEMMING's weaker solution or after NAWASHIN's method, but equally good results were obtained with material preserved many years ago in strong alcohol by Dr. HENNING E. PETERSEN. In some cases, in specimens preserved in FLEMMING's solution or in alcohol,

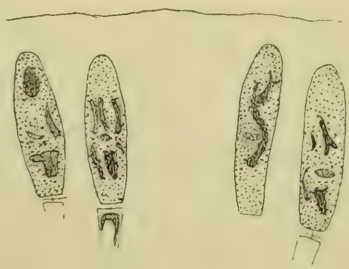


Fig. 12. Same material as fig. 11. Four end-cells from the same section showing nucleus and chromatophores, the latter apparently partly fusing together. 1800 : 1.

the chromatophores could not be observed, but usually they were very distinct in a number of 2 or 4 or rarely more. The shape of the chromatophores is very variable, ribbon-shaped, rod-shaped, linear with attenuated ends, sometimes very long and curved or spirally twisted. Their staining power after HEIDENHAIN's method is considerable, often greater than that of the nucleolus. The most remarkable feature in the young monosporangia is the fact that the chromatophores are not unfrequently found lying in pairs close together along their long axis as shown in several of the figures. When two chromatophores are exactly of the same length and are placed very close together, they

would seem to be the product of a longitudinal division (figs. 12, 13, 15), but as such a division of chromatophores has not hitherto, to my knowledge, been ascertained,

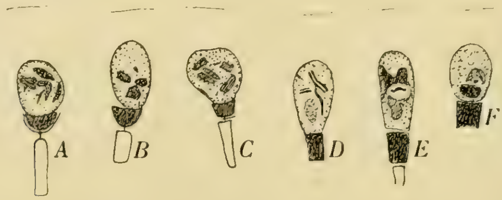


Fig. 13. From a nemathecium from Kerteminde, November (Nawaschin). The end-cells are swollen and show very distinct chromatophores, partly paired. The nucleus is indistinct in the three first figures. The cell beneath the monosporangium is short, deeply stained. 1015 : 1.

further proof must be demanded. On the other hand, the paired chromatophores might be supposed to be on the point of fusing together along the longitudinal axes, and this supposition is more in accordance with the cases

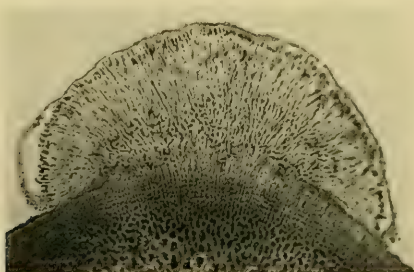


Fig. 14. Vertical section of nemathecium. Photograph. About 120 : 1.

where the paired chromatophores are of different lengths. This interpretation is corroborated by the fact that the ripe spores seem to contain one single chromatophore. Paired chromatophores were observed in end-cells which were still cylindrical and in more or less obovate, nearly ripe monosporangia.

As mentioned above, the resting nucleus in the terminal

cell has a distinct outer limitation and a large homogeneous nucleolus or central body staining more or less intensely with hæmatoxylin (Heidenhain). In other cases the central body is differentiated into small grains which stain intensely with hæmatoxylin. The number of these grains, which must be supposed to be chromosomes, was often seen

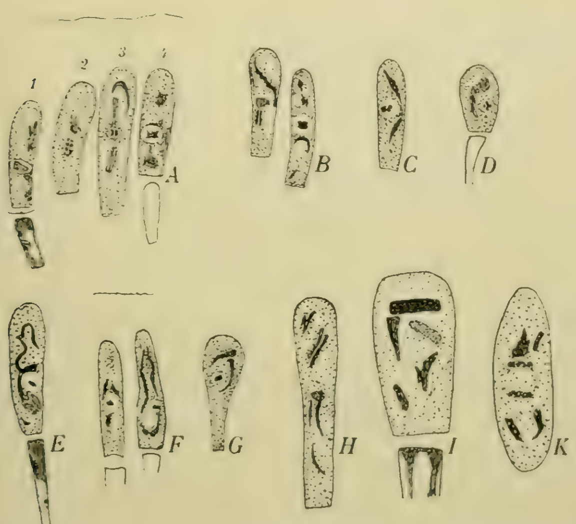


Fig. 15. From a nemathecium from Frederikshavn, Henn. Petersen, May (Alcohol, Heidenhain). End cells of nemathecial filaments showing very distinct chromatophores, partly paired, and nucleus. *A*, group of four end-cells; in *1* the nucleus is in the resting stage, in *4* apparently in the first dividing stage, in *2* the nucleus has lately divided and the two daughter nuclei show each four chromosomes but are still without nuclear membrane. Dividing stages further represented in figs. *B*, *C* (?), *K*. In fig. *I* the nuclear body is rod-shaped, homogeneous without nuclear membrane. *A*—*G*, 1015 : 1. *H*—*K*, 1800 : 1.

to be 4 (fig. 15). Dividing nuclei were rarely observed, most distinctly in the second cell from the left in fig. 15 *A*; two groups of 4 chromosomes each are here situated near one another in the axis of the cell, evidently arisen by division

of a nucleus like that in the cell to the right of it. The two daughter nuclei are still without nuclear membranes. Another division stage is shown in fig. 15 *K*, but here the chromosomes are not distinct. The nuclear divisions observed were evidently all mitotic. No indication of a synapsis

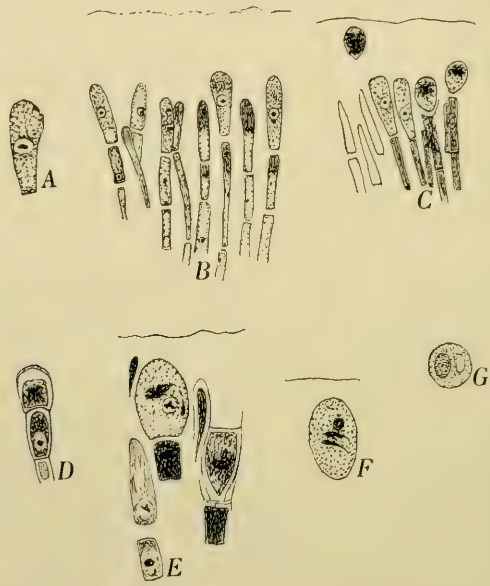


Fig. 16. *A—F*, from the same material as fig. 14. The chromatophores not distinct in figs. *A—C*. One end-cell in *B* contains two nuclei. Ripe monospores are present in *C*. *D*, the last cell contains a nearly ripe spore, a younger spore is developing in the cell beneath it. *E*, a spore has been exhausted to the right and a new monosporangium is developing beneath it. The narrow, clavate intensely stained cells are perhaps end-cells of primary nemathecial filaments. *F*, ripe monospore not yet set free showing nucleus and two chromatophores. *G*, living, ripe spore set free in May. *A—D*, 670 : 1. *E—F*, 1080 : 1. *G*, 670 : 1.

stage or a heterotypic division was ever met with. The formation of the monosporangia is thus not preceded by a reduction of the number of chromosomes, and this is in accordance with the fact that no fertilisation process has

been ascertained. The number of chromosomes in the young still dividing end-cells of the nemathecium being four, it must be supposed that the vegetative cells of the nemathecium and probably also of the frond have the same number of chromosomes, but owing to the small size of the vegetative nuclei, the chromosomes are very difficult to distinguish. Some observations seem, however, to show that there are really four chromosomes in the nuclei of the cortical and the medullary cells of the frond[1].

The nemathecia ripen in winter and are still to be found with ripe spores in May, but then they die and in summer *Ahnfeltia* is always sterile. The ripe nemathecia are hemispherical or usually elliptical or oblong, their long axis being parallel to the axis of the frond (fig. 1). The colour is yellowish[2].

The ripe monosporangia are ellipsoidic or obovate, but the spores set free are globular, about 8.5 μ in diameter. They contain numerous small refractive bodies (starch) and one single yellow-brown chromatophore, situated a little excentrically, and beside it a hyaline round spot the nature of which was not ascertained (nucleus or vacuole?) (fig. 16).

3. Germination of the spores.

Spores were sown in May 1927, fronds of *Ahnfeltia* with ripe nemathecia being put down on slides, partly sandblown, at the bottom of glass-vessels filled with sea-water from the Great Belt, where the fronds had been collected, and placed in a room facing north. The presence of the

[1] I am indebted to Dr. C. A. Jørgensen, to whom I have shown some of my slides, for having called my attention to such nuclei, but the observations still need confirmation.

[2] Greville (1830 p. 150) described them as dark coloured.

evacuated spores was ascertained, but the first stages of the germination were not observed. About three months after the sowing, small violet orbicular discs composed of a single layer of cells appeared, the smallest ones consisting of about 30 cells, the largest of much more. In several cases the discs bore single hyaline hairs (fig. 17). The young plants were kept alive for two years, but in the latter part

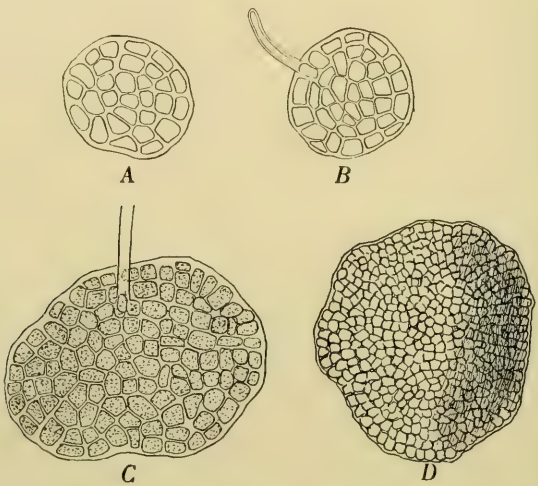


Fig. 17. Germlings obtained by sowing monospores in May 1927 on slides. *A—C* about three months old, in *B* a young hyaline hair springs from a marginal cell, in *C* a long hair springs from the disc. *D*, a two years old germling. *A—C*, 625 : 1. *D*, 350 : 1.

of this period they did not thrive well and finally perished. They had then increased considerably in circumference and were growing thicker in the middle owing to horizontal cell-divisions, but they showed no trace of an upright shoot. These small crusts agreed exactly in colour and structure with the expanded discs from which the upright shoots of *Ahnfeltia* spring (fig. 18), and there can be no doubt as to their identity. It must be emphasised that the basal discs

of *Ahnfeltia plicata* in Nature often reach a considerable size before the formation of upright shoots takes place. — The development of the disc-shaped young plants from the germinating monospores thus tells directly against SCHMITZ's hypothesis.

Fig. 18. Young frond springing from an expanded disc. 10 : 1 (?).

4. Conclusions.

The reproduction of *Ahnfeltia plicata* (and related species) is very peculiar and different from that of all other Florideæ. Antheridia, carpogonia, cystocarps and tetrasporangia are wanting. No organs of reproduction are known apart from the nemathecia. These bodies are different from other nemathecia known by their development and their function. While other nemathecia produce seriate tetrasporangia in the nemathecial filaments, those of *Ahnfeltia* produce monosporangia only in the last cell of the nemathecial cell-rows. But the cell-rows producing the monosporangia are not identical with the primary nemathecial filaments. These arise in autumn as outgrowths from a group of superficial cells of the frond dividing by transverse cell-walls. In these cell-rows two kinds of particular cells are early produced (in October):

1) flask-shaped cells arising from the end-cells of the cell-rows, most frequently at the bottom of the nemathecium and consequently often terminal on the cortical cell-rows. These cells remind one of carpogonial cells by their shape and like these stain deeply with hæmatoxylin, but this coloration touches only or in particular the cell-wall, whereas the content is feebly developed, homogeneous and apparently slightly stained and the nucleus not or scarcely visible. These cells are further terminal on

vegetative cell-rows, not at the end of particular carpogonial filaments lateral on the latter, as in other Florideæ, and they are always included, not with protruding end. It must therefore be concluded that they cannot be considered as more or less modified carpogonial cells. They might better be compared with the sterile hairs occurring near the carpogonial branches in *Ptilota* (comp. Davis, Bot. Gazette, 22, 1896). They are doubtless reduced organs without function, not giving rise to any new formation.

2) The other kind of particular cells, the generative cells, as they have been named above, are, in contradistinction to the flask-shaped cells, productive. They arise at the top of the primary nemathecial filaments, by transformation of the end-cell or as a lateral outgrowth, they are rich in protoplasm and divide early with the consequence that they form small groups of active cells at the surface of the young nemathecium. From these cell-groups new cell-rows spring in a horizontal direction or directed upwards, with the result that numerous upward growing cell-rows are produced, forming a system of secondary nemathecial filaments issuing from an irregular layer situated near the bottom of the nemathecium. The cells of this layer are irregular of shape. The nemathecium is thus built up in two distinct phases. The primary nemathecium is a rather low cushion composed of closely placed primary nemathecial filaments of moderate length, being immediate continuations of the cortical cell-rows; at the border the cell-rows are shorter and diverging outwards. By the further development of the nemathecium the upper portion arises, exclusively or mainly, from the generative cells, or their derivates, and the secondary nemathecial filaments are, therefore, not continuations of the primary ones. The whole

complex of cells arising from the generative cells must be considered as representing a new generation, comparable to the sporophytic generation (*Actinococcus*) of *Phyllophora Brodiæi* (comp. K. Rosenvinge 1929) though there are essential differences. The *Actinococcus* generation arises in a fertile segment of the frond from an auxiliary cell, in a similar manner to a gonimoblast, which process, according to H. Clauszen (1929) and Kylin (1930 p. 27) must be supposed to have been preceded by a fertilisation, so that the nuclei of the sporophyte are diploid (8 chromosomes) whereas those of the gametophyte are haploid (4 chromosomes). The secondary (fertile) nemathecial cell-rows in *Ahnfeltia* arise from several, perhaps numerous, generative cells produced in particular organs: the primary nemathecia. The question then arises, what morphological significance must be attributed to the generative cells. Some would perhaps prefer to consider them as organa sui generis without any relation to other reproductive cells in the Florideæ, but this view, I think, is not satisfactory. The young groups of generative cells offer some resemblance with the incompletely developed procarps which occur so frequently in *Phyllophora Brodiæi* (K. Rosenvinge 1929 fig. 10) and it appears not unlikely that they are, like these, reduced procarps, though differentiated carpogonia and auxiliary cells have never been ascertained. If this interpretation is right, it must be assumed that there are a great number of starting points for the secondary nemathecial filaments in the same nemathecium, though perhaps not so many as might be supposed because several of the cell-groups may be produced by the horizontally running cell-rows (comp. fig. 6) and a number of the cell-groups do not perhaps produce nemathecial filaments. By this

multiple origin of the sporogenous cell-rows the nemathecium of *Ahnfeltia* differs essentially from that of *Phyllophora Brodiæi*, where the whole complex of nemathecial filaments normally derives from one auxiliary cell.[1]

Further, as mentioned above, the nemathecial filaments of *Ahnfeltia* differ by not producing tetrasporangia but monosporangia which are not seriate but develop only in the end-cells. The question of the morphological significance of the monosporangia is no easy matter to solve. The fact that they occur in nemathecia suggests that they might be interpreted as originating from tetrasporangia which have failed to be divided owing to the wanting reduction division of the nuclei. Such a division at any rate does not take place in the monosporangia and it seems too to be precluded at any earlier moment; its occurrence seems further to be improbable as a fertilisation or an apomictic process has not been ascertained.

The secondary nemathecial filaments may also be interpreted as gonimoblast cell-rows arising by apogamy from the generative cells, and the whole complex of secondary nemathecial filaments would then be a compound cystocarpium, the gonimoblast filaments issuing from numerous generative cells. According to this view the monospores are to be regarded as carpospores: the nemathecia represent the carposporophytic phase and the tetrasporophytic phase is wanting. Such a compound cystocarp is not otherwise known among Florideæ.

The fact that the spores are terminal on sterile cell-

[1] It seems, however, that a large *Actinococcus* nemathecium may sometimes arise by fusion of primordia of nemathecia issuing from two or perhaps more contiguous auxiliary cells (comp. K. Rosenvinge 1929 p. 22 plate figs. V—VIII).

rows does not seem favourable to this view, as cystocarps of such a structure do not occur within *Gigartinales* to which the genus *Ahnfeltia* is usually referred. The interpretation of the secondary nemathecial filaments as gonimoblast filaments would be in better accordance with the facts known supposing that *Ahnfeltia* were related to the *Cryptonemiales* where both sexual and sporophytic nemathecia occur, and where cystocarps with a structure showing some resemblance to that of the nemathecia of *Anfeltia* are known (e. g. *Polyides*). The frond and the young, primary, nemathecia can be regarded as the gametophyte with modified procarps: the generative cells, which produce the secondary nemathecial filaments representing the sporophytic phase.

The number of chromosomes is four in the nuclei of the spores as well as in the nuclei of the secondary nemathecial filaments from which they arise, and probably the same number occurs in both phases of *Ahnfeltia*. This number must be the haploid number as no reduction of the chromosome number occurs and no fusion of nuclei has been ascertained, although not rarely fusions of cells occur in the first (gametophytic) phase as well as the sporophytic phase.

One or the other interpretation may be right, the nemathecium of *Ahnfeltia* will in any case remain a very peculiar formation otherwise hitherto unknown among Florideæ.

Postscript.

The researches of which the present paper gives an account were completed in the spring of 1930 and were intended to be embodied in the fourth part of my publication: The Marine Algæ of Denmark, which I hoped to complete at the end of 1930. As an illness prevented me from working for a long time, I preferred to publish my investigations on this subject in a separate paper which I succeeded in finishing and sending to the Academy for publication at the end of October 1930. It was only in November that I became acquainted with the note af B. D. Gregory: New light on the so-called parasitism of Actinococcus aggregatus, Kütz. and Sterrolax decipiens, Schmitz (Annals of Botany, vol. 44, no. 177, July 1930), which the author has kindly sent to me.

To judge from the short account of this note, the results of Gregory seem in the main to be in accordance with mine. The author maintains that *Sterrocolax* is not of parasitical nature but that the development of the cushions begins with a localized hypertrophy of the cortical tissue of *Ahnfeltia*. Within such a tissue he found filaments "terminated by darkly-staining somewhat pointed apices, and it is believed that these filaments give rise to the extramatrical tissue of *Sterrocolax*". It seems not improbable that these filaments or their darkly-staining apices might be identical with the generative cells described above. The author observed fusions between the medullary cells in the

neighbourhood of the nemathecia and he thinks it possible that they represent a very much reduced sexuality, a view with which I cannot agree. Monospores were grown in culture, but "after three to five months, only rudimentary disc-like structures have been obtained". GREGORY found in the medullary cells both a four and an eight chromosome complex, but he adds that it is not yet known whether the eight chromosome condition bears any relation to the cell-fusions. There is some evidence that there are eight chromosomes in the apical cells and in the monospores of *Sterrocolax decipiens*". As mentioned above, I found four chromosomes in the apical cells of the nemathecia; when eight chromosomes were observed in such a cell, it was shortly after the division of the nucleus. The author concludes that the mode of origin of *Sterrocolax decipiens* and its similarity in structure to *Ahnfeltia plicata* suggest the probability that it is the asexual biont of its so-called "host".

At the same time appeared another paper treating the same subject, namely E. CHEMIN: Ahnfeltia plicata Fries et son mode de reproduction. Bull. de la soc. bot. de France, t. 77 p. 342-354. The author examined the structure of the nemathecia but he did not observe the "Senker" of SCHMITZ. He points out that SCHMITZ did not say anything about the origin of the parasite and emphasizes the continuity of the cell-filaments at the boundary between the cortex and the nemathecium, but the photograph (plate IV) representing a vertical section of a nemathecium[1] also shows numerous cells intensely stained with hæmatoxylin in the bottom layer of the nemathecium. It seems probable that these cells are identical with those which I have described above as flask-shaped, though CHEMIN, who has observed them,

[1] Not a gall, as erroneously said at the foot of the plate.

does not mention their shape. The photograph further shows, at a higher level, in particular to the right, groups of darker cells which might possibly be identical with the generative cells mentioned above and their derivates.

In examining the germination of the monospores, Chemin observed the first stages of the young plants which I have not seen. He found that the germinating spore produced a short articulate cell-filament giving rise at its distal end to a disc which after two weeks might consist of some twenty cells. Though the smallest discs observed by me were only slightly larger than these, I have not observed any trace of such a germinating filament. The rare hyaline hairs observed in my cultures have nothing in common with it. It is remarkable that Chemin did not meet with any trace of chromatophores or phycoerythrine in the spores, while I found a distinct yellowish chromatophore. After one month the greatest discs measured 40 μ in diameter and were thicker in the middle than at the border. After two months the discs were only slightly more developed but they had multiplied by proliferation. Chemin concludes that the discs are probably the beginning of *Ahnfeltia*.

Bibliography.

C. A. AGARDH (1822), Species Algarum. Vol. I pars posterior.

J. G. AGARDH (1851), Species genera et ordines Algarum. II pars 2.

— (1876). — Pars III (Epicrisis).

T. H. BUFFHAM (1893), On the Antheridia, etc., of some Florideæ. The Journal of the Quekett Microscopical Club, Vol.V, ser. II.

HUGO CLAUSZEN (1929), Zur Entwicklungsgeschichte von Phyllophora Brodiaei. Ber. d. Deutsch. Botan. Gesellschaft. Bd. 47.

English Botany. Vol. 16. 1803.

R. K. GREVILLE (1830), Algæ Britannicæ.

L. KOLDERUP ROSENVINGE (1929), Phyllophora Brodiæi and Actinococcus subcutaneus. K. D. Vid. Selsk. Biologiske Meddelelser. 8. Bind, 4, København.

F. T. KÜTZING (1869), Tabulae phycologicae 19. Bd. Nordhausen.

H. KYLIN (1930), Über die Entwicklungsgeschichte der Florideen. Lunds Univ. Arsskrift. N. F. Avd. 2, Bd. 26, Nr. 6.

H. C. LYNGBYE (1819), Tentamen Hydrophytologiæ Danicæ. Hafniæ.

FR. SCHMITZ (1894), Die Gattung Actinococcus Kütz. Flora.

FR. SCHMITZ and P. HAUPTFLEISCH (1896), Gigartinaceae. Engler u. Prantl, Die natürl. Pflanzenfam. I,2.

Forelagt paa Mødet den 14. November 1930.
Færdig fra Trykkeriet den 28. Februar 1931.

BIOLOGISKE MEDDELELSER

UDGIVNE AF

DET KGL. DANSKE VIDENSKABERNES SELSKAB

6. BIND (Kr. 18,10):

	Kr. Ø.
1. Lundblad, O.: Zur Kenntnis der Quellenhydracarinen auf Møens Klint nebst einigen Bemerkungen über die Hydracarinen der dortigen stehenden Gewässer. Mit 7 Tafeln und 5 Textfiguren. 1926	5.00
2. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. II. Phæophyceæ. 1926	6.00
3. Ostenfeld, C. H.: The Flora of Greenland and its Origin. 1926	3.35
4. Fibiger, Johannes and Møller, Poul: Investigations upon Immunisation against Metastasis Formation in Experimental Cancer. With 5 plates. 1927	2.75
5. Lind, J.: The Geographical Distribution of some Arctic Micromycetes. 1927	1.50
6. Børgesen, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part 1. Bangiales and Nemalionales. 1927	4.50
7. Lindhard, J.: Nogle Undersøgelser over den respiratoriske Kvotient under kortvarigt Muskelarbejde. 1927	1.00

7. BIND (Kr. 14,85):

1. Raunkiær, C.: Dominansareal, Artstæthed og Formationsdominanter. 1928	1.75
2. Petersen, C. G. Joh.: On some Biological Principles. 1928	2.00
3. Vimtrup, Bj.: Undersøgelser over Antal, Form, Bygning og Overflade af Glomeruli i Nyren hos Mennesker og nogle Pattedyr. 1928	1.30
4. Bensley R. R. og Vimtrup, Bj.: Undersøgelser over de Rouget'ske Cellers Funktion og Struktur. En Metode til elektiv Farvning af Myofibriller. 1928	1.00
5. Thomsen, Oluf: Die Erblichkeit der vier Blutgruppen des Menschen, beleuchtet durch 275 Nachkommenschaftsindividuen in 100 AB (IV)-Ehen (nebst 78 Kindern, von denen nur der eine (AB)-Elter bekannt ist). 1928	1.00
6. Krogh, A. and Hemmingsen, A. M.: The Assay of Insulin on Rabbits and Mice. 1928	0.70
7. Johnsson, J. W. S.: L'Anatomie mandchoue et les Figures de Th. Bartholin, étude d'iconographie comparée. 1928	2.00
8. Kemp, Tage: Om Kromosomernes Forhold i Menneskets somatiske Celler. 1929	1.75
9. Weis, Fr.: Fysiske og kemiske Undersøgelser over danske Hedejorder. Med særligt Henblik paa deres Indhold af Kolloider og Kvælstof. With a Resumé in English. 1929	8.25

8. BIND (KR. 14,95):

Kr. Ø.

1. BØRGESEN, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part II. Cryptonemiales, Gigartinales and Rhodymeniales. Les Mélobésiées par M^me Paul Lemoine. Avec 4 planches. 1929 .. 4.50
2. THOMSEN, OLUF og KETTEL, KARSTEN: De menneskelige Isoagglutininers og tilsvarende Blodlegemereceptorers Styrke i forskellige Levealdre. Med 1 Tavle. 1929 .... 1.60
3. KRABBE, KNUD H.: Recherches sur l'existence d'un œil pariétal rudimentaire (le corpuscule pariétal) chez les mammifères. Avec 11 planches (22 figures). 1929 .... 2.80
4. ROSENVINGE, L. KOLDERUP: Phyllophora Brodiæi and Actinococcus subcutaneus. With one plate. 1929 .... 2.40
5. THOMSEN, OLUF og KETTEL, KARSTEN: Kvantitative Undersøgelser over de menneskelige Isoagglutininer Anti-*A* og Anti-*B*. 1929 .... 0.65
6. MADSEN, TH. et SCHMIDT, S.: Toxine et antitoxine diphtériques. 1930 .... 2.00
7. LUNDBLAD, O.: Die Hydracarinen der Insel Bornholm. Mit 9 Tafeln und 1 Textfigur. 1930 .... 5.00
8. LINDHARD, J. and MÖLLER, JENS P.: On the Origin of the Initial Heat in Muscular Contraction. 1930 .... 1.00

9. BIND (KR. 17,45):

1. BØRGESEN, F.: Marine Algæ from the Canary Islands, especially from Teneriffe and Gran Canaria. III. Rhodophyceæ. Part III. Ceramiales. 1930 .... 7.50
2. OSTENFELD, C. H. and SYRACH LARSEN, C: The species of the Genus Larix and their geographical distribution. With 35 illustrations and 8 maps. 1930 .... 5.00
3. SCHMIDT, S.: Eksperimentelle Undersøgelser over forskellige Elektrolyters Indflydelse paa Difteritoksinets og det antidifteriske Serums Stabilitets- og Neutralisationsforhold med særligt Henblik paa Reaktionshastigheden imellem Toksin og Antitoksin. 1930 .... 5.50
4. HAGERUP, O.: Études des Types biologiques de Raunkiær dans la flore autour de Tombouctou. Avec 5 Planches. 1930 ..... 5.25

10. BIND (under Pressen):

1 JENSEN, AD. S.: Der grosse europäisch-sibirische Kreuzschnabelzug 1927. 1930 .... 1.00
2. KOLDERUP ROSENVINGE, L.: The Reproduction of Ahnfeltia Plicata. 1931 .... 1.75

THE BOTANY
OF
ICELAND

EDITED
BY

L. KOLDERUP ROSENVINGE
PH. D.

AND

EUG. WARMING (†)
PH. D., SC. D.

VOL. II PART III

9. POUL LARSEN:
FUNGI OF ICELAND

WITH 20 FIGURES IN THE TEXT AND A COLOUR CHART

(PUBLISHED BY THE AID OF THE CARLSBERG FUND)

COPENHAGEN
J. FRIMODTS FORLAG

LONDON
HUMPHREY MILFORD
OXFORD UNIVERSITY PRESS

1932

9.

FUNGI OF ICELAND

BY

POUL LARSEN

WITH 19 FIGURES IN THE TEXT AND A COLOUR CHART

1931

PREFACE

In 1921 I was requested by the editors of this work to make a journey to Iceland for the purpose of investigating the fungi of that country, more particularly the Icelandic *Hymenomycetes,* among which especially the *Agaricaceae* occupied a less important place in previous works on the fungi of Iceland than their supposed number would seem to warrant. The journey was made at the expenses of the Carlsberg Fund.

In addition I undertook to work up the results of my own observations with the lists of Icelandic fungi previously published.

The results are now at hand in the present paper.

With few exceptions I have myself examined the fungi given in the list either in their localities or in the Herbarium of Icelandic Fungi in the Botanical Museum at Copenhagen.

Of the fungi collected by me those growing on dung and some of the *Fungi imperfecti* have been examined and determined by Magister O. Rostrup, for which I tender him my cordial thanks.

I owe special thanks to the editors of *The Botany of Iceland* for the confidence they reposed in me by entrusting me with this work, and for the grants for its completion which they have procured for me.

INTRODUCTION

Historical Account of Investigations on the Fungi of Iceland.

Literature:

(1) O. F. Müller: Enumeratio stirpium in Islandia sponte crescentium. Nova Acta Ac. Nat. Cur. 1772.

(2) Johan Zoëga: Flora Islandica. Tilhang til Eggert Ólafssons Rejse igennem Island. Sorø 1772.

(3) Bjørn Halldórsson: Grasnytiar. Kaupmannahøfn 1783.

(4) Nicolai Mohr: Forsøg til en Islandsk Naturhistorie. Kiøbenhavn 1786.

(5) Sveinn Pálsson: Dagbog, holden paa hans Rejse til og i Island 1791—93. Skrifter af Naturhistorieselskabet, 3. Bind, 1. Hæfte, pp. 178—179. Kjøbenhavn 1793.

(6) W. J. Hooker: Journal of a tour in Iceland in the summer of 1809. Yarmouth 1811.

(7) G. S. Mackenzie: Travels in Iceland in 1810, Edinburgh 1811, p. 433.

(8) Th. Gliemann: Geographische Beschreibung von Island 1824, p. 171.

(9) Thienemann und Günther: Reise im Norden Europa's vorzüglich in Island in den Jahren 1820 bis 1821, p. 320. Leipzig 1827.

(10) Óddur J. Hjaltalín: Íslenzk Grasafræði. Kaupmannahøfn 1830.

(11) E. Robert in Paul Gaimard: Voyage en Islande et au Groenlande exécutée pendant les années 1835 et 1836 sur la corvette La Recherche, Paris, 1840, 7e fascicule, p. 355.

(12) J. Vahl in the above-mentioned work by Paul Gaimard, 7. fascicule, p. 379.

(13) L. Lindsay: Flora of Iceland, Edinburgh New Philos. Journal, Vol. XIV, 1861.

(14) Chr. Grønlund: Islandske Svampe, Botanisk Tidsskrift, 3. Række, 3. Bind, pp. 72—76. Kjøbenhavn 1879.

(15) E. Rostrup: Islands Svampe, Botanisk Tidsskrift, 14. Bind, pp. 218—229. Kjøbenhavn 1885.

(16) C. J. Johanson: Svampar från Island, Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar 1884, Nr. 9. Stockholm 1885.

(17) E. Rostrup: Islands Svampe, Botanisk Tidsskrift, 25. Bind, pp. 281—335. København 1903.

(18) E. Rostrup: Liste over Svampe samlede paa Island 1903—05 af Helgi Jónsson, Ó. Daviðsson og C. V. Prytz — in manuscript in the Library of the Botanical Garden. Copenhagen 1905.

The figures in brackets are quoted in the following in references to this literature.

The first botanical investigation of Iceland which included the fungi was made by J. G. König in 1765—66 with the object of collecting plants for the *Flora Danica*.[1] His collection of fungi forms the basis of the lists contained in C. F. Müller's Enumeratio (1) and in Zoëga's Flora Islandica (2). These lists comprise respectively 11 and 12 species which, however, are identical except for 2. In 1783 Bjørn Halldórsson's Grasnytiar (3) appeared. In this 7 species of fungi are mentioned by their Icelandic names, of which 2, at any rate, are not to be found in the above-mentioned lists. This brings up the number of species to 15. These 15 species reappear without additions in (4), (6), (7), and (8). Thienemann's and Günther's investigations (9) of the Icelandic vegetation in 1820 and 1821, and Hjaltalín's Íslenzk Grasafræði (10) add each one species to the number. Robert's and Vahl's lists (11) and (12) bring up the number to 19. L. Lindsay's Flora of Iceland 1861 (13) only gives 13 species, adding no new ones, and 5 of the earlier 6 species are declared by Berkeley (p. 70) to be impossible to determine. Rostrup, however, regards this reduction as partly unfounded (15). —

The 19 species of fungi given in these earlier lists are the following: —

Humaria granulata (Bull.), *Geopyxis Ciborium* (Vahl), *G. cupularis* (L.), *Chlorosplenium aeruginosum* (Fl. D.), *Lachnea scutellata* (L.), *Helvella atra* König, *Clavaria muscoides* (L.), *Psalliota campestris* (L.), *Psilocybe ericaea* (Pers.), *Russula fragilis* (Pers.), *Boletus scaber* Bull., *B. laevis* Fr., *B. bovinus* L., *B. luteus* L., *Globaria Bovista* (L.), *Bovista clavata* Fr., *Crucibulum vulgare* Tul.

The lists further contain a couple of Agaricaceae which must be considered doubtful. The same applies to *Boletus laevis*, *B. bovi-*

[1] See Carl Christensen, Den Danske Botaniks Historie, p. 118.

nus and *B. luteus* (see note on this subject in the succeeding main list of Icelandic fungi).

In 1876 the Danish botanist Chr. Grønlund made a journey in Iceland and collected, in addition to other plants, 24 species of fungi. A list of these is given in his paper (14).

In 1885 E. Rostrup published in Botanisk Tidsskrift (15) the results of a critical comparison of all the lists of Icelandic fungi hitherto issued, together with a number of *Micromycetes* which he had found on flowering plants in Icelandic herbaria. The number of known species of Icelandic fungi was thus brought up to 89.

In the period 1889—1903 our knowledge of Icelandic fungi was considerably extended. Simultaneously with E. Rostrup's »Islands Svampe« 1885, appeared C. J. Johanson's »Svampar från Island« (16), containing 57 species, 31 of which were new for Iceland. — In addition a large material was sent to the Botanical Museum at Copenhagen and to E. Rostrup personally, consisting partly of herbaria of Phanerogams, from which Rostrup gathered a rich harvest of Micromycetes, and partly of collections of fungi. The Icelanders, Dr. phil. Helgi Jónsson, Dr. phil. Th. Thoroddsen, Stefán Stefánsson, and cand. Ólafur Daviðsson sent considerable collections of fungi to Rostrup during this period. This applies especially to Ólafur Daviðsson, who sent in about 400 species during the period 1885—1903. — Also Danish botanists, e. g. Dr. C. H. Ostenfeld and Arthur Feddersen, brought home collections of fungi from journeys to Iceland.

From these collections in conjunction with the results of continued investigations of herbaria of flowering plants from Iceland, E. Rostrup worked up a new list of the fungi of Iceland in 1903 (17), which comprised 543 species, including all species from previously published lists of fungi from Iceland.

From the period after 1903 we have still another list — though not a very comprehensive one — in a manuscript from the hand of E. Rostrup in the Botanical Museum of Copenhagen (18). It contains some species of fungi, not previously recorded from Iceland, collected and sent in by Helgi Jónsson, Ó. Daviðsson, and Professor C. V. Prytz. This brings to an end the considerable work done by E. Rostrup on the fungi of Iceland (1905).

The material since then sent in to the Botanical Museum of Copenhagen by Helgi Jónsson has been determined by the mycologists J. Lind and Professor C. Ferdinandsen. Of Danish bota-

nists Svend Andersen has, during several journeys in Iceland, collected a herbarium of flowering plants and vascular cryptogams, which he has kindly lent me for examination in regard to fungi. The mycologist N. Fabritius Buchwald visited Iceland in the summer of 1923 and brought home a collection of 23 Icelandic species of fungi (among which was one new species for Iceland). These he has kindly sent me for examination.

On my journey in Iceland in 1922 my general purpose was the investigation of fungi, while my special object was to make a study of the *Agaricaceae*, the determination and description being made in the field from fresh material. The colours were determined by comparison with colour charts; other macroscopical characters were noted down in the field. Microscopic characters were examined by means of a travelling microscope, and in addition, material of all the species was brought back in alcohol so that the microscopical characters could subsequently be revised.

The main list of Icelandic fungi contained in this work is a result partly of my own observations of fungi in Iceland and partly of my study of all the earlier lists of Icelandic fungi and of the material on which they are based. The greater part of this material is in the Botanical Museum of Copenhagen, and I have tested the determination of the listed species by means of it, and, in so far as errors were found, I have corrected them. This brings up the number of known species of fungi in Iceland to 802, including, however, some few species of Agaricaceae which I have not been able to identify with known species, while, on the other hand, I have not had sufficient material to establish them as new species.

Icelandic Localities investigated in Search of Fungi.

Large parts of the highlands in the interior are covered with ice, and still greater areas have a covering either of unweathered or of only slightly weathered lava, so that these regions are almost devoid of vegetation. It is chiefly the depressions, the erosion valleys, and the lower coast stretches of the fiords which harbour the vegetation necessary for the development of fungi. The collectors, therefore, have mainly confined their investigations to such tracts. Thus the Icelanders Olafur Daviðsson and Stefán Stefánsson have almost exclusively examined the fiord and river valleys of N.W. Iceland, while Helgi Jónsson has especially investigated the

S. W. country, but also a smaller area in the east country. The finds of C. H. Ostenfeld are mainly derived from the north, north-west and west country, and Chr. Grønlund has visited both the east, north and west country. — My own investigations in the summer of 1922 began in the first part of June in S. W. Iceland, viz. in the country round Reykjavík, Hafnarfiörður and Þingvellir. In the latter part of June I continued with the part round Borgarfjörður, especially the birch copses near Borg and Norðtúnga. But my main area of investigation was N. E. Iceland, the region between the Øfiord Valley and the east coast of Iceland, viz. the Øfiord Valley itself and the Fnjóskadalur running parallel to it, the depression near Mývatn with Laxádalur, Jökulsá á Heiði from Grímstaðir to Möðrudalur, Jökulsá á Brú, Lagarfljót with Iceland's largest birch copse, and finally the region round Seyðisfjörður.

As will appear from this survey, the south country is the least explored part of Iceland as regards fungi. The extensive bare sands along the southern coast of the country cannot, however, be expected to add to the number of species, for even though there is some dune vegetation here, a similar vegetation occurs on the extensive range of dunes along Jökulsá á Heiði. The few samples of the vegetation of sands and dunes derived from Helgi Jónsson's collection show in the main the same fungi as those occurring on the plants collected by me on dunes in the interior round Grímstaðir near Jökulsá á Heiði. And the homefields of the farms in the south country bear mainly the same vegetation as the homefields in the rest of the country, and must therefore be supposed to harbour much the same fungi. On the whole, such large areas of Iceland have now been investigated that all the different forms of vegetation are represented, and an addition to the number of species is more likely to be made through a more thorough examination of details than by enlarging the area of investigation.

The Special Conditions of Environment offered to Fungi in Iceland.

Though the fungus flora is greatly dependent on the rest of the vegetation, we cannot infer from this that the more luxuriant the vegetation of a country is, the richer and more abundant its fungus flora will be. At any rate, this does not apply to the larger fungi. There must, therefore, be other factors besides the chlorophyllaceous

vegetation which condition the growth of the fungi. As actual woods are entirely absent in Iceland, or only present in the shape of low birch copses in sheltered valleys and on moist valley slopes, it might be expected, from the occurrence and distribution of the larger fungi in Central Europe, that but few of these would be present in Iceland, and that they would chiefly occur in the aforementioned birch copses. This, however, is by no means the case. For though the number of known species of the larger fungi in Iceland is not very great (about 150), the individual species have a wide distribution and are very frequent in some localities, even outside the birch copses. In river plains, on mountain slopes, in outlying pastures and homefields, occur, primarily, the larger fungi also to be found outside forests in Central Europe, for instance species of the genera *Mycena*, *Tricholoma*, *Omphalia*, *Russuliopsis*, *Hygrophorus*, *Leptonia*, *Psalliota*, *Stropharia*, *Panaeolus*, *Galera*, *Naucoria*, *Inocybe*, *Lycoperdon*, and *Bovista*. But there also occur species of genera that chiefly or exclusively inhabit woods, such as *Cortinarius*, *Pholiota* and *Russula*. Of these genera Cortinarius is almost exclusively an inhabitant of woods in Central Europe; but several species of it are very numerously represented in Iceland in river plains, fiord valleys, and knolly moorland tracts. It would seem, therefore, that these fungi do not prefer our woods on account of their trees and bushes, but on account of the special climate prevalent there, a climate which may be found in Iceland outside the woods, and which is especially characterised by a relatively greater moisture of the atmosphere than that usually present outside woods in Central Europe.

The sporophores of certain of these fungi show peculiar adaptations to the somewhat altered environment. Thus, in river plains and knolly outlying pastures, among grasses, sedges and mosses, several species of the genera *Inocybe* and *Cortinarius* occur in dense clusters. They have short stems and small pilei, whereas the same species in Central Europe, as forest fungi, form scattered sporophores with long stems and larger pilei. The advantage gained in the former case is that the sporophores, on account of their shorter stems, develop in a stratum of the atmosphere in which they are not exposed to desiccation, and the numerous small pilei can develop just as many spores as the fewer but larger ones.

Further, veiled forms occur, with the veil so well developed, that until they are closely examined, one is apt to regard them as

new species. This, for instance, is the case with *Naucoria myosotis*, the older sporophores of which are provided with a distinct ring, and the younger pilei of which have the gills covered with a dense filmy veil. The same applies to several *Cortinarii*. The well developed veil is also a striking feature in many species of the genera *Inocybe*, *Hebeloma*, and *Galera*, though in the latter genus only in species of the group *Bryogenae* Fr.

The cool and moist climate has also considerable influence on the distribution, density, and time of fructification of the Micromycetes, both directly and more indirectly, by affecting the host plants. The period of drought so common in Central Europe in June and July, which arrests fructification in most of the saprophytes among these fungi, is unknown in Iceland. *Discomycetes* and *Pyrenomycetes* fructify all the summer both in the lowlands and in the highland tracts as far as the vegetation extends. — The withered leaves and stems of most herbaceous plants survive through the winter and provide a fertile soil for these fungi. In Central Europe a great many herbaceous plants appear so early that they wither already during the drought in the summer and become a prey to the rich bacterial life of the moist autumn, disappearing without leaving any trace at the beginning of the winter. Not so in Iceland where these plants appear late. Their decay occurs at such an advanced stage of the summer that the cold and snow-covering prevent the breaking down activities of the bacteria and the fungi, and when the snow-covering melts in the succeeding early summer, large quantities of withered leaves and stems are left, on which numerous fungi thrive. These, in conjunction with the bacteria, complete the work of decay. That the Micromycetes competing with the bacteria in the dissimilation of the vegetable substances are stronger in this climate than in Central Europe appears from the greater abundance with which these fungi occur on the decaying parts of plants. While the collector in Central Europe must examine withered leaves and stems very carefully in the field if he wants to bring home any spoil at all, a quite inexperienced collector may gather a rich harvest of Micromycetes in Iceland by merely collecting at random any dead parts of plants at any time of the summer.

The luxuriant development of this microflora may be in part due to the fact that the phanerogams have a looser structure and feebler strengthening tissue than the same species of plants in more

southerly latitudes. For the leaves this has been demonstrated by Dr. F. Børgesen in his paper »Bidrag til Kundskaben om arktiske Planters Bladbygning« in Botanisk Tidsskrift, Vol. 19, Copenhagen 1895, and by Bonnier in »Comptes rendus« 1894, t. CXXIII, p. 1427. — As a circumstance pointing in the same direction I may mention that a great many Cyperaceae which are quite valueless as fodder in Central Europe, are highly valued feeding plants in Iceland both for horses and cows. Icelandic hay is »richer in nourishment« than hay in more southern latitudes — in its native land the Icelandic pony can work on a fodder of hay alone, which perhaps shows that the Icelandic plants have a feebler mechanical tissue and therefore are more easily digested and give a greater surplus of energy to the animals.[1]

That the epidermis of these plants is thinner and the cuticle weaker appears plainly enough in the preparation of the perithecia of Pyrenomycetes or pycnidia of Sphaeroidaceae imbedded in their leaves and stems. It is much easier than the same work with leaves and stems of similar plants in Central Europe. The looser structure evidently makes it easier for the hyphae of the fungi to penetrate into the body of the plants. Also the predominant isolateral structure of the leaf (see Børgesen's above-mentioned paper) renders invasion easier, as there are stomata on either side of the leaf.

Immigration of the Fungi into Iceland.

While the answers to the questions dealt with above relating to the fungi of Iceland were based on facts or on conclusions drawn from facts, the case is different when we attempt to solve the problem treated in the present section.

In the first place our knowledge of the geographical distribution of the species of fungi is rather uncertain. In the second place we do not know the full extent of the means the fungi have of

[1] Compare the quotation from P. Feilberg at p. 253, vol. I of this work, and the references to the literature. From these it would seem to appear that in Feilberg's opinion Icelandic ponies and cows have in the course of many generations adapted themselves to the Icelandic Cyperaceae and »coarser« grasses, and that it may be partly owing to this circumstance that they derive so much nourishment from these plants. But this argument does not cover the facts, for, when in Denmark, Icelandic ponies are unable to work on hay alone, but must have oats added to their fodder.

spreading, especially when, as in the present case, the oceans set up barriers to their migrations. And yet, since the fungi of Iceland are in the main identical with those of the surrounding countries (in so far as the vegetation with which the fungi are associated is common to both), this shows that an exchange of fungi must have taken place.

It seems very unlikely that the spores of the fungi could have been carried, either by direct spreading or by means of currents in the air, across the great stretches separating Iceland from the nearest countries, in such large quantities that they would be likely to reach localities where conditions of germination were present.

It is much more likely that the spreading of the fungi takes place indirectly. Detached fragments of phanerogams containing living parts of fungi may be carried along by the wind during heavy snowstorms and be swept over the polar ice, which generally in the winter bridges over the seas between the lands in arctic regions and also sometimes reaches the coasts of Iceland.[1]

There are, however, other ways by which the fungi may travel. After the settlement of Iceland many culture plants have been introduced into Iceland and with them no doubt many fungi. In the following we shall mention some quite recent examples of such an immigration of fungi. During the recently awakened interest in horticulture in Iceland, which even went as far as the planning of coniferous plantations, (a project that had to be given up, however, after several unsuccessful trials), a number of plants were introduced, which have since become infested with species of fungi previously unknown in Iceland. These fungi, therefore, have probably been brought into Iceland with the host plants.

This applies to the following species:

Lophodermium pinastri.......	on Pinus montana
Phyllosticta Pseudacori	- Iris germanica
Phoma endolenca	- Alnus glutinosa
Aposphaeria glomerata } Coniothyrium olivaceum }	- Ulmus montana
Phoma tingens	- Aconitum sp.

[1] J. Lind, The Geographical Distribution of some Arctic Micromycetes. Det Kgl. Danske Vidensk. Selsk. Biologiske Meddelelser, VI, 5. Copenhagen 1927.

R. Sernander, Den skandinaviska vegetationens spridningsbiologi. Upsala 1901.

Plowrightia ribesia	
Leptosphaeria Ribis	on Ribes rubrum
Phoma ribicola	
Phomopsis ribesia	
Phoma Malvacei	- Ribes alpinum
Hendersonia Ribis alpini	
Diplodia Rubi	- Rubus idaeus
Cytospora leucostoma	- Prunus padus
Comarosporium laburnicum	
Rabenhorstia rudis	- Cytisus laburnum
Coniothyrium Laburni	
Phytophthora infestans	
Phoma solanicola	- Solanum tuberosum
Fusarium Solani	
Sphaerulina intermixta	- Lonicera sp.

I shall mention one more example of the recent immigration of a *Boletopsis*, which, similarly to that of the above-mentioned fungi, seems to have taken place simultaneously with the introduction of the plant with which its existence is intimately bound up. This is *Boletopsis luteus.* — In a small plantation in the birch copses near Hallormsstaðir in E. Iceland, there is an area with 10–12 year old *Pinus montana.* Here for the first and only time in Iceland I found *Boletopsis luteus.*[1]

Upon inquiry the forester who had laid out the plantation informed me that none of these pines had been planted, but were all raised from imported seeds! In this case the most natural explanation of the occurrence of the fungi would seem to be that the spores were introduced with the seeds.

[1] In Bjorn Halldórsson's Grasnytiar 1783, *Boletus (Boletopsis) luteus* is stated to be growing in Iceland. From here this statement has found its way into Mohr's Islandsk Naturhistorie, 1786, and finally, with a reference to these sources, into Rostrup's lists of Icelandic fungi. None of the numerous other botanists who have subsequently searched for fungi in Iceland have, as far as I know, ever seen any trace of this easily recognisable fungus. As moreover *B. luteus* forms mycorrhiza with coniferous trees only, these early statements cannot possibly be correct.

ENUMERATION OF THE FUNGI OF ICELAND

In the following list of fungi now known from Iceland the classification is founded on the system given by Ernst Gäumann in his work: Vergleichende Morphologie der Pilze, Jena 1926.

The following abbreviations are used for the names of the collectors of fungi most frequently named in the list:

O. D. = Ólafur Daviðsson.
H. J. = Helgi Jónsson.
P. L. = Poul Larsen.
C. H. O. = C. H. Ostenfeld.
St. St. = Stefán Stefánsson.

When a species has been collected in several localities, these are, as far as possible, arranged according to their distribution in the following succession: East-, North-, North-West-, West- and South-Iceland (comp. J. Boye Petersen, this work, Vol. II, part II, p. 259).

The designations in the descriptions of the *Agaricaceæ* consisting of a letter and a figure, e. g. g 4, refer to the colour plate accompanying this paper; it has been painted by Mr. Jakob E. Lange for his paper, Studies in the Agarics of Denmark, Part VI (Dansk Botanisk Arkiv, Bd. 4, Nr. 12, 1926), and reprinted here with the consent of the author.

MYXOMYCETES.

Clathroptychiaceae.

Enteridium Ehrenberg.

1. **E. olivaceum** Ehrenberg, Jahrbücher für Gewächskunde, herausgegeben von Sprengel, Schrader und Link, Bd. 1, Heft. 2, p. 55.

Húsafellsskógur (O. D.). — On birch wood.

Trichiaceae.

Trichia Haller.

2. **T. contorta** (Ditmar) Rostafinski.

Lycogala contorta Ditmar: Sturm, Deutschlands Flora III, Pilze, Bd. I, p. 9, t. 5.

Hofsfjall (O. D.). — On Sibbaldia procumbens.

Physaraceae.

Physarum Persoon.

3. **P. cinereum** (Batsch) Persoon.

Lycoperdon ciner. Batsch, Elenchus fungorum, p. 155.

Möðruvallanes (O. D.). — Substratum unknown.

Didymaceae.

Lepidoderma De Bary.

4. **L. carestianum** (Rabenhorst) Rostafinski.

Reticularia carest. Rabenhorst, Fungi europ. exsicc., No. 436.

Hestahraun in Þorvaldsdalur (O. D.). — On stems of a Hieracium.

Stemonitaceae.

Lamproderma Rostafinski.

5. **L. physaroides** (Albertini et Schweinitz) Schroeter.

Stemonitis phys. Alb. et Schw., Conspectus fungorum, p. 103, t. II, f. 8.

Hofsfjall (O. D.). — In the panicle of Deschampsia caespitosa.

6. **L. violaceum** (Fries) Rostafinski.

Stemonitis violacea Fries, Systema mycologicum III, p. 162.

Möðruvellir (O. D.). — On straws of Anthoxanthum odoratum.

Comatricha Preuss.

7. **C. nigra** (Persoon) Rostafinski.

Stemonitis nigra Persoon: Gmelin, Systema naturae, p. 1467.

Þingvellir (P. L.). — On wood of Betula pubescens.

EUMYCETES.

Synchytriaceae.

Synchytrium De Bary et Woronin.

8. **S. cupulatum** Thomas, Botanisches Centralblatt, XXIX, 1887 p. 19.

Helgavatn, Möðruvallafjall (St. St.). — On leaves of Dryas octopetala.

9. **S. aureum** Schroeter, Saccardo, Sylloge fungorum VII, p. 290.

Möðruvellir (O. D.). — On leaves of Ranunculus reptans.

10. **S. globosum** Schroeter, Sacc., Syll. fung. VII, p. 288.

Baldurheimsholt (O. D.). — On leaves of Veronica anagallis.

11. **S. groenlandicum** Allescher. Pilze aus dem Umanakdistrikt. Bibliotheca botanica, Heft 42, 1897, p. 40.

Hlíðarháls (O. D. og St. St.). — On Saxifraga hypnoides.

Cladochytriaceae.

Physoderma Wallroth.

12. **P. menyanthis** De Bary, Sacc., Syll. fung. VII, p. 318.

Ós and Laugarvatn (O. D.). — On leaves of Menyanthes trifoliata.

13. **P. Heleocharidis** (Fuckel) Schroeter, Sacc., Syll. fung. VII, p. 317.

Möðruvellir (O. D.). — On stems of Heleocharis palustris.

14. **P. vagans** Schroeter, Sacc., Syll. fung. VII, p. 318.

Hof in Hörgárdalur (O. D.). — On leaves and petioles of Comarum palustre and Caltha palustris.

15. **P. Hippuridis** Rostrup, Grønl. Svampe 1891, p. 631.

Hraun in Fljót (O. D.). — On leaves of Hippuris vulgaris.

16. **P. Crepidis** Rostrup, Isl. Svampe 1903, p. 286.

Hraun in Fljót (O. D.). — On the upper surface of leaves of Crepis paludosa.

Saprolegniaceae.

Saprolegnia Nees von Esenbeck.

17. **S. ferax** (Gruithusen) Nees, Sacc., Syll. fung. VII, p. 269.

Möðruvellir [O. D.]. Det. E. Rostrup. — On the larvae of butterflies.

Peronosporaceae.

Phytophthora De Bary.

18. **P. infestans** (Montagne) De Bary, Saccardo, Syll. VII, p. 237.

Experimental station at Eiðar [P. L.]; experimental station at Reykjavík [Buchwald]; garden at Reykjavík [Sæmundsson]. — On leaves of Solanum tuberosum.

Cystopus Léveillé.

19. **C. candidus** (Persoon) Léveillé, Sacc., Syll. fung. VII, p. 334.

Grafarbakki [O. D.]; Vík [H. J.], Muli near Geysir [Feddersen]; Reykjavík [Svend Andersen]. — On leaves and stems of Draba incana, Cardamine hirsuta, Capsella bursa pastoris.

Plasmopara Schroeter.

20. **P. densa** (Rabenhorst) Schroeter.

Peronospora densa Rabenhorst, Herbar. mycol. edit. 1. No. 1572.

Viðey [C. H. O.]. — On leaves of Rhinanthus minor.

Peronospora Corda.

21. **P. Alsinearum** Caspary, Saccardo, Syll. fung. VII, p. 246.

Hof [O. D.]; Eskifjörður and Dýrafjörður [C. H. O.], Víghólsstaðir [H. J.]. — On Cerastium alpinum and C. trigynum.

22. **P. Ficariae** Tulasne, Sacc., Syll. fung. VII, p. 251.

Hofsfjall [O. D.]; Reykjavík [C. H. O.]. — On Ranunculus acer.

23. **P. parasitica** (Persoon) Tulasne.

Botrytis parasitica Fries, Syst. Myc. III, p. 403.

Hof, Torfastaðir [O. D.]. — On Capsella bursa pastoris and Cardamine pratensis.

24. **P. Trifoliorum** De Bary, Sacc., Syll. fung. VII, p. 252.

Hof [O. D.]. — On Trifolium repens.

25. **P. Viciae** (Berkeley) De Bary, Sacc., Syll. fung. VII, p. 245.

Grafabakki [O. D.]. — On Vicia cracca.

26. **P. grisea** (Unger) De Bary, Sacc., Syll. fung. VII, p. 255.

Reykjavík [C. H. O.]. — On Veronica serpyllifolia.

27. **P. alta** Fuckel, Sacc., Syll. fung. VII, p. 262.

Vogar near Mývatn [St. St.]. — On Plantago major.

28. **P. calotheca** De Bary, Sacc., Syll. fung. VII, p. 245.

Hof [O. D.]; Melstaður [Feddersen]. — On Galium verum and G. boreale.

Mucoraceae.

Mucor Micheli.

29. **M. Mucedo** Fries, Syst. Myc. III, p. 320.

Möðruvellir, Hof, Fagriskógur, Vidvík [O. D.], det. E. Rostrup. — On sour milk and skin. Common on rotting objects (Mohr).

30. **M. Mucerdae** (Fries) Lind, Danish fungi, p. 71.

Mucor racemosus Fresenius, Sacc., Syll. fung. VII, p. 200.

Seyðisfjörður, Hlíðarfjall near Mývatn [P. L.]. — On ptarmigan droppings, cow- and horse-dung.

Rhizopus Ehrenberg.

30a. **R. nigricans** Ehrenberg, Sacc., Syll. fung. VII, p. 112.

Hlíðarfjall near Mývatn [P. L.] — On ptarmigan droppings.

Pilobolus Tode.

31. **P. Kleinii** van Tieghem, Sacc., Syll. fung. VII, p. 185.

Ós, Hof [O. D.]. — On horse and sheep-dung.

Phycomyces Kunze.

32. **P. nitens** (Agardh) Kunze, Sacc., Syll. fung. VII, p. 205.

Hraun in Fljót [St. St.], det. E. Rostrup. — In an old cask containing cod liver oil.

Entomophthoraceae.

Empusa Cohn.

33. **E. Muscae** Cohn, Sacc., Syll. fung. VII, p. 251.

Gásir; coastal cliff near Ós; Skriða [O. D.], det. E. Rostrup. — On various species of flies.

Protomycetaceae.

Protomyces Unger.

34. **P. pachydermus** Thuemen, Sacc., Syll. fung. VII, p. 319.

Möðruvellir. [O. D.]. — On stems and leaves of a Taraxacum sp.

Taphrinaceae.

Taphrina Fries.

35. **T. betulina** Rostrup, Tidsskrift for Skovbrug, Bind 6, 1883, p. 296.

Norðtúnga [P. L.]. — On Betula pubescens.

36. **T. nana** Johanson, Bihang t. Vetenskaps-Akademiens Förhandlingar 1885, p. 34, tab. I, fig. 1.

Gaunguskarð, Hofsfjall, Húsavík [O. D.]. On Betula nana.

37. **T. carnea** Johanson, Bihang t. Vetenskaps-Akademiens Förhandlingar 1885, p. 43, tab. I, fig. 5—6.

Þórðarstaðarskógur, Þórðarstaðir, Möðruvellir, Hofsfjall [O. D.]; Möðruvellir [St. St.]. — Eskifjörður [C. H. O.]; Hallormstaðir, Hálsskógur, Norðtúnga, Þingvellir [P. L.]. — On Betula pubescens, Betula intermedia and Betula nana.

38. **T. bacteriosperma** Johansson, Taphrinaceae II, p. 19, f. 11—12.

Efstibær (south-western Iceland) [H. J.]. — On leaves of Betula nana.

Gymnoascaceae.

Gymnoascus Baranetzky.

39. **G. myriosporus** Rostrup, Østgrønlands Svampe, Meddel. om Grønl. **18,** 1894, p. 12.

Dýrafjörður [N. Hartz]. — On cow-dung.

Aspergillaceae.

Aspergillus Micheli.

40. **A. herbariorum** (Wiggers) Schroeter, Pilze Schlesiens II, p. 215.

Mucor herbariorum Wiggers, Primitiae florae holsaticae, p. 111.

In several places [O. D. and St. St.]. — On withered parts of plants.

41. **A. repens** (De Bary) Schroeter, l. c. p. 215.

Eurotium repens De Bary, Beiträge III, p. 19.

Fagriskógur, Hof [O. D.]. — On bones.

Penicillium Link.

42. **P. crustaceum** (Linné) Fries, Syst. Myc. III, p. 407.

Möðruvellir [St. St.]. Det. E. Rostrup. — On jam in a cellar.

43. **P. candidum** Fries, Syst. Myc. III, p. 409.

Kaldalón [St. St.]. — On withered leaves of birch.

Nos. 42 & 43 were only found in the conidium stage.

Erysiphaceae.

Erysiphe Link.

44. **E. communis** (Wallroth) Fries, Sum. veg. Scand., p. 406.

Hof in Hörgárdalur [O. D.]. — On Draba incana.

45. **E. Cichoracearum** De Candolle, Flore française II, p. 274.

S. W. Iceland [H. J.], Hofsfjall, Hestarhaun in Þorvaldsdalur [O. D.]. — On Myosotis arvensis and on Hieracium species.

46. **E. Graminis** De Candolle, Flor. fr. VI, p. 106.

Hof in Hörgardalur [O. D.]. — On several species of grasses.

Sphaerotheca Léveillé.

47. **S. humuli** (De Candolle) Burrill, Salmon, A monograph of the Erysiphaceae, New York 1900, p. 45.

Hof in Hörgardalur [O. D.]. — On Draba incana.

48. **S. humuli** (De Candolle) Burrill var. fuliginea (Schlechtendal) Salmon, A monograph of the Erys., p. 45.

Hof in Hörgardalur [O. D.]. — On Taraxacum vulgare.

Podosphaera Kunze.

49. **P. myrtillina** Kunze, Mycologische Hefte II, p. 111.

Hofsfjall [O. D.]. — On Vaccinium uliginosum.

Dothioraceae.

Dothiora Fries.

50. **D. Sorbi** (Wahlenberg) Fuckel.

Hysterium Sorbi Wahlenberg, Flora lapponica, p. 523.

Bíldsfell (Feddersen). — On dead branches of Sorbus Aucuparia.

Plowrightia Saccardo.

51. **P. ribesia** (Persoon) Saccardo, Syll. fung. II, p. 635.

Sphaeria ribesia Persoon, Usteri, N. Ann. d. Bot. V, p. 24.

The experimental stations at Akureyri and Reykjavík and in several gardens in Reykjavík [P. L.]. — Very common on branches of Ribes rubrum.

The asci measure $90—100 \times 16—17\,\mu$ (pars sporifera).

The spores measure $22—37 \times 7—10\,\mu$ (22×9, 26×7, 30×10, 29×9, 22×10, 30×10, 37×10, $32 \times 9\,\mu$).

Pseudosphaeriaceae.

Pyrenophora Fries.

52. **P. phaeocomes** (Rebentisch) Fries, Summa vegetabilium Scandinaviae, p. 398.

Sphaeria phaeocomes Rebentisch, Flora neomarchicae, p. 338.

Fornhagagil [O. D.]. — On leaves of Anthoxanthum odoratum.

53. **P. hispidula** (Niessl) Saccardo, Syll. fung. II, p. 287.

Pleospora hispidula Niessl, Notizen über Pyrenom., p. 32.

In the plantation at Grund [P. L.]. — On withered stems and leaf-sheaths of Luzula multiflora.

54. **P. Androsaces** (Fuckel) Saccardo, Syll. fung. II, p. 19.

Pleospora Androsaces Fuckel, Symbolae, Nachtrag II, p. 19.

Occurs throughout Iceland, in the lowlands as well as in the fell-fields. [Strömfelt and P. L.]. — On withered stems and leaves of Cerastium alpinum, Draba alpina, Pedicularis flammea, but most frequently on Silene acaulis.

55. **P. comata** (Niessl) Saccardo, Syll. fung. II, p. 286.

Pleospora comata Niessl, Beiträge zur Kenntniss der Pilze, 1872, p. 30.

Bær in Hrutafjörður (St. St.); Þorvaldsdalur, Hallgilstaðafjall, Fornhagagil and Hofsfjall (O. D.). — On Alsine biflora, Cerastium alpinum, C. vulgatum and Viscaria alpina.

56. **P. hispida** (Niessl) Saccardo, Syll. fung. II, p, 284.

Þingvellir in Almannagjá [P. L.]. — On withered stems of Arabis petraea and Arenaria ciliata.

57. **P. chrysospora** (Niessl) Saccardo, Syll. fung. II, p. 173.

Pleospora chrysospora Niessl, Hedwigia 1880, p. 173.

Grows in all parts of the country on a number of herbaceous plants: Equisetum sp., Festuca rubra, Tofieldia borealis, Rumex acetosa, Oxyria digyna, Cerastium arcticum, Alsine biflora, A. hirta, A. stricta, Arenaria ciliata, Viscaria alpina, Cardamine bellidifolia, Draba incana, Arabis alpina, A. petraea, Thalictrum alpinum, Saxifraga caespitosa, S. hypnoides, S. rivularis, Sedum annuum, Potentilla maculata, Rubus saxatilis, Vicia cracca, Plantago maritima, Primula stricta, Rhinanthus minor, Euphrasia latifolia, Bartsia alpina, Veronica saxatilis, V. alpina, Gentiana nivalis, G. campestris, Erigeron neglectus, Taraxacum vulgare, Hieracium islandica and other Hieracium sp.

58. **P. chrysospora** (Niessl) Saccardo, var. **polaris** Karsten, Hedwigia 1884, p. 38.

Mountain slopes facing Lagarfljót near Hallormstaðir [P. L.].

On withered stems, leaves, and sepals of Saxifraga aizoides. Diameter of perithecia 200 μ. Bristles straight or undulate, 80—90 $\times$ 4—5 μ. Asci cylindric-clavate with a short broad stalk, 8-spored, 120—135 $\times$ 32—35 μ (p. sporifera). Spores yellowish brown, cylindric-ovate, ends obtuse, 7 transverse septa, 1—3 longitudinal septa, the end cells having 1, the median cells 3. 8 measurements of the spores produced

the following results: 33×15.5, 35×15, 40×16, 32×17, 30×14, 36×17.5, 35×17, $28 \times 13\,\mu$.

59. **P. phaeocomoides** Saccardo, Syll. fung. II, p. 280.

Grund near Akureyri in a small plantation [P. L.]. — Rumex acetosa, Vicia cracca, Achillea millefolium.

60. **P. abscondita** Karsten, Hedwigia 1884, p. 37.

In the plantation at Grund [P. L.]. — On Rhinanthus minor.

61. **P. coronata** (Niessl) Saccardo, Syll. fung. II, p. 283.

Pleospora coronata Niessl, Notizen über neue und kritische Pyrenomyceten, p. 16.

Möðruvellir, Hof [O. D.]. — On withered stems of Achillea millefolium.

Pleospora Rabenhorst.

62. **P. straminis** Saccardo, Michelia I, 407, Fungi ital. autogr. del. t. 329.

P. straminis, E. Rostrup Isl. Svampe 1903, p. 308.

Hestahraun [O. D.]. — On Trisetum spicatum.

P. straminis is not, however, present on the straws of Trisetum spicatum, found in the capsule marked *Pleospora straminis* in the Icelandic Herbarium at the Botanical Museum of Copenhagen, whereas a number of *Pleospora Karstenii* are found on these straws, so it is possible that there may be a mistake and that *Pleospora straminis* Sacc. should, consequently, be expunged from the list of Icelandic fungi.

63. **P. Karstenii** Berlese et Voglino.

Pleospora arctica Karsten, Sacc., Syll. fung. II, p. 171.

Hestahraun [O. D.]. — On dead stems of Deschampsia flexuosa and Trisetum spicatum.

This species is very closely allied to *Pleospora islandica* Johanson.

64. **P. microspora** Niessl, Notiz. üb. Pyrenom., p. 16.

Gásaeyri [O. D.]. — On Elymus arenarius.

65. **P. punctiformis** Niessl, Notiz. üb. Pyrenom., p. 24.

Skagafjörður [Strömfelt]. — On withered petioles of Agrostis canina.

66. **P. islandica** Johanson, Svampar från Island, p. 170.

Hólar in N. Iceland [Strömfelt]. In a bog near Hallormstaðir and at Hálskógur near Akureyri [P. L.]. — On withered straws and leaves of Poa caesia, Agropyrum caninum and Trisetum spicatum.

67. **P. pentamera** Karsten, Fungi in insulis Spetzbergen, p. 99.

Fornhagagil, Hestahraun in Þorvaldsdalur [O. D.], Guðlaugsvík [G. Guðmundsson]; Jökulsá á Fjöllum at Grímstaðir [P. L.]. — On dead stems and leaves of Poa caesia, Trisetum spicatum, Glyceria sp. and Juncus balticus.

68. **P. vagans** Niessl, Notiz. üb. Pyrenom., Brünn 1876, p. 14.

Möðrudalur, Grímstaðir, Grund [P. L.], Vífilsstaðahlíð near Hafnarfjörður, Þingvallavatn [Feddersen]. — On Elymus arenarius and Luzula multiflora.

P. vagans Niessl, var. **Airae** Niessl, l. c.

The plantation at Rauðavatn, Reykjavík [P. L.]. — On withered straws of Deschampsia caespitosa.

69. **P. gigaspora** Karsten, Hedwigia 1884, p. 37.

P. gigantasca Rostrup, Isl. Svampe 1903, p. 307.

Blown sand areas between Grímstaðir and Möðrudalur near Jökulsá á Fjöllum (P. L.). Without mention of any locality this species was sent from Iceland to E. Rostrup by Daniel Bruun. Further recorded from Sandey in Þingvallavatn [Feddersen]. — On dead stems, leaves, and chaffs of Elymus arenarius.

70. **P. discors** (Montagne) Cesati et De Notaris, Sacc., Syll. fung. II, p. 230.

Hof, Hjeðinshöfði [O. D.]; bog in low fell-fields south of Akureyri [P. L.]. — On Eriophorum Scheuchzerii, Carex incurva and on dry leaves of Carex rigida.

71. **P. scirpicola** (De Candolle) Karsten, Mycologia fennica II, p. 72.

Sphaeria scirpicola De Candolle, Flor. fr. II, p. 809.

Möðruvallafloi [O. D.]. — On withered leaf-sheaths and stems of Scirpus palustris.

72. **P. Triglochinis** Har. et Briard, Sacc., Syll. fung. II, p. 878.

Höfn in Hafnarfjörður [St. St.]. — On stems of Triglochin maritimum.

73. **P. Spartii** Saccardo et Berlese. in Berlese Monografia dei generi Pleospora, Firenze 1888, p. 86.

In a bog south of Akureyri [P. L.]. — On dead stems of Juncus triglumis.

74. **P. Junci** Passerini et Beltrani, Sacc., Syll. fung. II, p. 273.

Víðidalur near Jökulsá á Fjöllum [P. L.]. — On petals and the upper part of the stem of dead Juncus balticus.

P. Junci Passerini et Beltrani var. **Luzulae** (Feltgen).

P. spinosella Rehm var. Luzulae Feltgen.

In a birch copse at Þingvellir [P. L.]. — On withered stems of Luzula spicata.

Asci: 100 × 26—28 μ, 8-spored. The spores: 28 × 10 μ, 7 transverse septa, one longitudinal septum through all the joints except the end cells.

75. **P. Elynae** Rabenhorst (Cesati et De Notaris, Schema di classificazione degli Sferiacei Italici aschigeri (Comment. Soc. crittog. Ital. vol. I), p. 44.

Clathrospora Elynae Rabenhorst, Hedwigia I, Taf. XX, fig. 3.

Víðidalur near Jökulsá á Fjöllum, bog in Øfjordsdal [P. L.]; Gásir and Hof [O. D.]. — On withered stems of Juncus balticus and J. triglumis.

76. **P. deflectens** Karsten, Fungi in insulis Spetsbergen, p. 99.

The plantation near Grund south of Akureyri [P. L.]. Fagriskógur [O. D.]. — On dead stems of Vicia cracca and Rhodiola rosea.

77. **P. alpina** Rostrup, Isl. Svampe 1885, p. 7.

Kalmanstúnga (Grønlund). — On dead stems of Viscaria alpina.

78. **P. Drabae** Schroeter, Ein Beitrag zur Kenntnis der nordischen Pilze, p. 15. Jahresb. d. schles. Ges. 1881.

Vaðlaheiði [Strömfelt]; Hofsfjall, Hallgilsstaðafjall [O. D.]. — On Draba nivalis and Draba hirta.

79. **P. vulgaris** Niessl, Notiz. üb. Pyrenom., p. 27.

Seyðisfjörður [Feddersen], Krossastaðagil and Hof [O. D.]; in littoral, meadows and Hrafnagjá on Thingvellir at Akureyri [P. L.]. — On Potentilla maculata, Oxyria digyna, Thymus serpyllum, Hieracium islandicum and Tofieldia borealis.

80. **P. herbarum** (Persoon) Rabenhorst, Herb. mycol. Edit. II, p. 547.

Sphaeria herbarum Persoon, Synopsis methodica fungorum, p. 79.

Of common occurrence throughout the country and found on withered stems, leaves, and fruits of a number of plants, both dicotyledons and monocotyledons: Silene maritima, Cerastium alpinum, C. vulgatum, Alsine verna, A. biflora, A. rubella, Draba nivalis, Arabis petraea Cardamine bellidifolia, Rumex acetosella, Dryas, Potentilla maculata, Thalictrum alpinum, Linum catharticum, Viola tricolor, Saxifraga caespitosa, S. oppositifolia, Statice armeria, Thymus serpyllum, Campanula uniflora, Galium silvestre, Cirsium arvense, Erigeron alpinum, Hieracium sp., Tofieldia borealis. Elymus arenarius, Anthoxanthum odoratum, Agrostis sp.

Though this species is very widespread in Iceland and occurs on

many different host-plants, its density is much less than in Central Europe. In this respect it falls far short of *Pyrenophora chrysospora*.

As is well known, *Pleospora herbarum* is a very polymorphous species, especially with regard to the dimensions of the perithecia, asci and spores. But the species is variable in other respects, too. On Saxifraga corniculata, Primula veris, Pulsatilla vulgaris and Polygonatum multiflorum the spores of *P. herbarum* may have a wide coating of mucus. On Lotus corniculatus, on which plant the perithecia may be found on the stem as well as the pods, I have found 4-spored asci on the stem, and at the same time 8-spored asci on the pods. The spores in the 4-spored asci were $48-50 \times 18-20\,\mu$, whereas the spores in the 8-spored asci measured $30-50 \times 14-15\,\mu$. Typically the upper and lower halves of the spores are asymmetrical, but on thin dead branches of Hippophaës rhamnoides, where *P. herbarum* also occurs, these halves are symmetrical If these deviations from the type are constant, the species *P. herbarum* should rightly be divided into several species, but as this has by no means been established, I have included the various Icelandic forms under one species.

The most divergent form of *P. herbarum* which I have seen in Iceland, is that occurring on Rumex acetosella, which has both spore-ends somewhat acuminate, while the breadth of the spores is small compared with their length, the dimensions being $33-36 \times 11-12\,\mu$; hence the proportion of length to breadth is 3 in this case, whereas the typical value of this ratio ranges from 2 to 2.5.

Leptosphaeria Cesati et De Notaris.

81. **L. Equiseti** Karsten, Fungi in insulis Spetsbergen, p. 101. Stockholm 1872.

Tröllafoss [Svend Andersen]; Hallormstaðir, the plantation at Grund south of Akureyri, Almannagjá near Þingvellir [P. L.]. — On withered pieces of the stem of Equisetum variegatum.

In the literature two different views of this species prevail. However, Karsten's description of *L. Equiseti* in Mycologia Fennica II, Pyrenomycetes. p. 101. will perhaps cover both of them. In The Micromycetes of Svalbard, Skrifter om Svalbard og Ishavet, N. 13, Oslo 1928, Pl. II, figs. 15a and 15b, J. Lind has given a figure of the asci and spores of *L. Equiseti* Karsten, which agrees perfectly with the *Leptosphaeria*, found on Equisetum variegatum in Iceland. But a different conception of L. Equiseti Karsten has been given by Berlese in Icones Fungorum. Pyrenomycetes Vol. I, p. 54. The *Leptosphaeria* figured here by Berlese shows considerable deviation, in regard to the dimensions both of the asci and the spores, and especially in regard to the form of spore, from Lind's Svalbard form and from the Icelandic form. On the other hand, the diagnosis given in Berlese's figure agrees with a *Leptosphaeria*, which is very common — at any rate in Denmark — on *Equisetum hiemale*, where it grows on the dead internodes of the stems so common at the apices of the stems in all growths of *Equisetum hiemale*. It must, however, be supposed that Berlese received the material for his figure of this *Leptosphaeria* from Karsten, and that Karsten must have in-

cluded the two forms under the same species. This, however, is hardly correct. It is true that the two forms of *Leptosphaeria* must probably be placed in the same line of development, but at a greater distance from one another than is usually allowed in systematic mycology for fungi that must be included under the same species.

82. **L. Marcyensis** (Peck) Saccardo, Syll. fung. II, p. 80.

Almannagjá [O. D.]. — On stems of Lycopodium selago.

83. **L. arundinacea** (Sowerby) Saccardo, Syll. fung. II, p. 62.

Brattifjallgarður [St. St.]. — On dead stems and leaves of Calamagrostis stricta.

84. **L. culmifraga** (Fries) Cesati et De Notaris, Syll. fung. II, pp. 75 and 77.

Mývatn (Grønlund); Karlskáli (Strömfelt); Hraunsvatn [O. D.]; Grímstaðir near Jökulsá á Fjöllum, Sluttnes in Mývatn, Hálsskógur and Rauðavatn near Reykjavík [P. L.]. — On dead stems and leaves of Poa nemoralis, Poa caesia, Poa alpina, Milium effusum, Deschampsia caespitosa, Elymus arenarius, Luzula spicata, Kobresia scirpina.

85. **L. microscopica** Karsten, Fungi in insulis Spetsbergen, p. 102.

L. culmorum Auerswald and L. typharum (Desmazières) Karsten.

Hofsós and Hálsskógur (Strömfelt); Nýjahraun and Sandanesmál [St. St.]; Hestahraun [O. D.]; Þingvellir [P. L.]. — On Poa alpina, Agrostis canina, Puccinellia maritima and Armeria vulgaris f. elongata.

86. **L. Fuckelii** Niessl, Oesterr. botan. Zeitschr. 1882, No. 11.

Hof [O. D.]; the plantation at Grund south of Akureyri [P. L.]. — On Calamagrostis stricta and Deschampsia caespitosa.

87. **L. culmicola** (Fries) Auerswald, Leipziger Bot. Tausch-Verein 1866, p. 4.

Sphaeria culmicola Fries, Syst. Myc. II, p. 430.

Hofsfjall and Hof [O. D.]; on the island of Slutnes in Mývatn and Grund plantation near Akureyri [P. L.]. — On Poa alpina, Anthoxanthum odoratum, Deschampsia caespitosa and Milium effusum.

88. **L. nigrans** (Desmazières) Cesati et De Notaris, Schema, p. 61.

Vaglaskógur (O. D.]. — On leaf-sheaths of Agropyrum caninum.

89. **L. Elymi** n. sp.

The blown sand areas along Jökulsá á Fjöllum between Grímstaðir and Víðidalur [P. L.]. — On dead Elymus arenarius, springing from the axis of the inflorescence.

The gregarious perithecia seated beneath the periderm are globose with a short verruciform orifice the diameter of which is 180—270 μ.

Asci clavate, short-stalked, 7-spored, $80-112 \times 18-20\,\mu$. Spores biseriate or transversal, a pale yellowish brown, 5- or more rarely 6-septate, slightly constricted at the septa, the 3rd cell from the top prominent, straight or slightly curved, $25-32 \times 8.5-10\,\mu$. Numerous filiform, interwoven para-

Fig. 1.

Leptosphaeria Elymi n. sp.

a. Rachis of inflorescence with a few chaffs and mouths of perithecia × 3.
b. 2 perithecia × 20.
c. 2 asci with spores and paraphyses × 750.

physes. Allied to Metasphaeria scirpina (Winter) Sacc., but distinguished with coloured spores.

90. **L. Apogon** Saccardo et Spegazzini, Michelia I, p. 398.

Øfjordsdal near Akureyri [P. L.]. — On dead stems of Juncus triglumis.

The scattered perithecia seated beneath the epiderm, depresso-globose with short barely visible verruciform orifice, diameter 0.1—0.2 mm.

Asci cylindric-clavate, shortly stipitate, 8-spored, 60—70×12—14 μ. Spores biseriate, fusiform, yellowish brown with 3 transverse septa, 2nd cell from the top prominent, not or only slightly constricted at the septa, 20—24×5—6.5 μ.

91. **L. juncina** (Auerswald) Saccardo, Syll. fung. II, p. 66.

Sphaeria juncina Auerswald, Rabenhorst Fungi europ. No. 748.

Eskifjörður [Strömfelt]. — On dead stems and leaves of Juncus biglumis.

92. **L. Luzulae** Winter, Hedwigia 1872, p. 149.

Almannagjá near Þingvellir [P. L.]. — On dead stems and leaves of Luzula arcuata.

93. **L. oreophila** Saccardo, Michelia I, p. 120.

Asbirgi [St. St.]. — On dead leaves and stems of Tofieldia borealis.

94. **L. Silenes-acaulis** De Notaris, Comment. d. societá critt. ital., Vol. II, fasc. III, p. 485.

Reykjavík [Grønlund]; Eskifjörður [Strömfelt]; Möðruvellir [G. Gudmundsson]: on sandy lava fields near Reykjavík [P. L.]. — On withered leaves of Silene acaulis and Silene maritima.

95. **L. Papaveris** Rostrup, Isl. Svampe 1903, p. 305.

Bóla in Blönduhlið [O. D.]. — On dead stems of Papaver radicatum.

96. **L. Doliolum** (Persoon) Cesati et De Notaris, Schema, p. 61.

Sphaeria Doliolum Persoon, Synops. meth. fung., p. 78.

On the island of Sluttnes in Mývatn and Vífilsstaðahlíð near Hafnarfjörður [P. L.]. — On dead stems of Archangelica officinalis and Rumex acetosa.

97. **L. Dryadis** Rostrup, Isl. Svampe 1903, p. 305.

Spónsgerði [O. D.], Sandafjall and Dýrafjörður [C. H. O.]. — On stems and fruits of Dryas octopetala.

98. **L. Ribis** Karsten, in Rev. Myc. 1885, p. 106.

Nursery garden at Hallormstaðir and the experimental station at Reykjavík [P. L.]. — On dead branches of Ribes rubrum.

Perithecia scattered, beneath the epiderm, diameter 0.1—0.2 mm. Asci cylindrical, stalked, the elongate asci 130×8 μ, the short ones 90×10 μ, 8-spored. Spores uni—biseriate, elongate-ellipsoidal, pale yellowish brown, typically with 3 transverse septa, but number of the spores gradually get 4 or even 5 transverse septa, a very few 6, some of the secondarily formed transverse septa are oblique, none of the cells are very prominent, 17—22×6—7 μ. Numerous delicate paraphyses; they are cylindrical, articulated, 4 μ wide.

This species is nearly allied to *L. hippophaēs* (Fabre) Rostrup.

99. **L. ogilviensis** (Berkeley et Broome) Cesati et De Notaris, Schema, p. 61.

Sphaeria ogilviensis B. et Br., Notic. of Brit. Fungi, No. 462.

Hestahraun in Þorvaldsdalur [O. D.]. — On dead stems of a Hieracium sp.

100. **L. agnita** (Desmazières) Cesati et De Notaris.

Sphaeria agnita Desm.; Annals des sciences natur. III serie, vol. 16, p. 313.

Hestahraun in Þorvaldsdalur and Fornhagagil [O. D.]. — On dead stems of Hieracium sp. and Geranium silvaticum.

Metasphaeria Saccardo.

101. **M. culmifida** (Karsten) Saccardo, Syll. fung. II, p. 174.

Vaðlaheiði [Strömfelt]. — On dead parts of Carex lagopina.

102. **M. macrotheca** Rostrup, Grønl. Svampe 1888, p. 561.

Vatnsdalsfjall [St. St.]. — On dead parts of Carex rigida.

103. **M. Junci** (Oudemanns) Saccardo, Syll. fung. II, p. 177.

Hrafnagjá near Þingvellir [P. L.]. — On dead stems of Luzula spicata.

The perithecia, seated gregariously beneath the epiderm are globose, though as a rule somewhat flattened, with a diameter of 0.2—0.3 mm and with a short orifice. Asci cylindrical, curved, stalkless or short-stalked, $70 \times 20\,\mu$, surrounded by filiform ca. $2\,\mu$ broad pseudoparaphyses, 8-spored. Spores biseriate, hyaline, fusiform, somewhat curved, ends obtuse, 3 transverse walls, without constrictions, with a mucous envelope, $20-22 \times 5-6\,\mu$.

104. **M. Arabidis** Johanson, Svampar fran Isl. 1884, p. 169, Figs. 11 a and bb, Tab. XXIX.

Reistarárgil, Þrastarhólsárgljúfur [O. D.]; Skagafjörður [P. Zophoniasson]; Eskifjörður [Strömfelt]. — On withered leaves of Arabis alpina and Arabis petraea.

105. **M. islandica** (Rostrup) P. Larsen.

Sphaerulina islandica Rostrup, Isl. Svampe 1885, pp. 218—239.

Brynjudalur [Grønlund]. — On dead stems of Arabis alpina.

106. **M. complanata** (Tode) Saccardo, Syll. fung. II, p. 161.

Sphaeria complanata Tode, Fungi mecklenburgenses, fig. 88.

Storugjá near Mývatn [P. L.]. — On dead stems and petioles of Geranium silvaticum.

107. **M. empetricola** Rostrup, Isl. Svampe 1903, p. 306.

Hof in Hörgardalur [O. D.]. — On decorticated stems of Empetrum nigrum.

108. **M. Empetri** (Fuckel) Saccardo, Syll. fung. II, 171.

Hestahraun in Þorvaldsdalur [O. D.]; Reykjahlíð near Mývatn [P. L.]. — On withered but still attached leaves of Empetrum nigrum.

109. **M. Angelicae** Rostrup, Isl. Svampe 1903, p. 306.

Grímstaðir near Mývatn [O. D.]; the island of Sluttnes in Mývatn [P. L.]. — On dead stems of Angelica silvestris and Archangelica officinalis.

Didymella Saccardo.

110. **D. proximella** (Karsten) Saccardo, Syll. fung. I, p. 558.

Sphaerella proximella Karsten, Mycologia Fennica II, p. 177.

Hörgardalur [O. D.]. — On dead leaves of Carex capillaris.

111. **D. inconspicua** Johanson, Svampar från Isl. 1884, p. 167.

Eskifjörður [Strömfelt]. — On dead leaves of Saxifraga oppositifolia.

Hypocreaceae.

Nectria Fries.

112. **N. coccinea** (Persoon) Fries, Sum. Veg. Scand., p. 368.

Sphaeria coccinea Persoon, Synops. meth. fung., p. 49.

Hálsskógur [O. D.]. — On birch-wood.

113. **N. Peziza** (Tode) Fries, Sum. Veg. Scand., p. 388.

Sphaeria Peziza Tode, Fungi Mecklenburgenses selecti II, p. 46.

Þingvellir [P. L.]. — On dead branches of Betula pubescens.

114. **N. Coryli** Fuckel, Ascm. N. 860, Hedwigia, XXII, p. 54.

In Reykjavík in gardens and in the grounds of the experimental station. — On dead branches of Salix phylicifolia.

The darkred, spherical, but soon crateriformly depressed perithecia are gathered in clusters which break through the periderm. Asci clavate $70-90 \times 10\,\mu$, as a rule with numerous small ($5-7 \times 1-1.5\,\mu$), cylindrical, curved, clear sporidia; but other asci occur, with 8 2-celled clear ascospores, lanceolate, with no constriction at the septum, straight or slightly curved $10-14 \times 2.5-3.5\,\mu$, often with a cylindrical appendage $5-6 \times 1\,\mu$, which is obstricted and gradually forms the above-mentioned sporidia. (Cf. Winter, Gymnoasceen und Pyrenomyceten, p. 114).

115. **N. cinnabarina** (Tode) Fries, Sum. Veg. Scand., p. 388.

Sphaeria cinnabarina Tode, Fungi mecklenburgenses selecti II, p. 9.

Reykjavík [Buchwald]; Sauðafell [Helgi Jonsson]; Hallormstaðir and Akureyri [P. L.]. — On branches of Ribes rubrum and Sorbus aucuparia.

Hypomyces Fries.

116. **H. chrysospermus** (Bulliard) Tulasne, Annales des sc. nat., Ser. IV, tom. XIII, p. 16.

Húsafellsskógur [O. D.]; Egilsstaðir [P. L.]. — On putrescent Boletus scaber.

Claviceps Tulasne.

117. **C. microcephala** (Wallroth) Tulasne.

Kentrosporium microcephalum Wallroth, Beiträge II, Taf. 3, Fig. 10—16.

S.W. Iceland [H. J]. — On Alopecurus pratensis and Poa pratensis.

118. **C. purpurea** (Fries) Tulasne.

Sphaeria purpurea Fries, Syst. Myc. II, p. 325.

Reykjavík [H. J.]. — On Festuca rubra.

Chaetomiaceae.

Chaetomium Kunze.

119. **C. indicum** Corda, Icones IV, p. 38.

Sacc., Syll. fung. I, p. 222.

Hlíðarfjall near Mývatn, N. Iceland [P. L.]. — On ptarmigan droppings. (Det. O. Rostrup).

Sordariaceae.

Sordaria Cesati et De Notaris.

120. **S. leucoplaca** (Berkeley et Ravenel) Ellis et Everhart.

Sphaeria leucoplaca B. et Rav., Grevillea IV, p. 143.

Hlíðarfjall north of Mývatn [P. L.]; det. O. Rostrup. — On ptarmigan droppings. N. Iceland: Hof in Hörgardalur [O. D.]. — On cow dung.

121. **S. coprophila** (Fries) Cesati et De Notaris, Schema, p. 52.

Sphaeria coprophila Fries, Syst. Myc. II, p. 342.

Geysir [O. D.]. — On sheep dung.

122. **S. curvula** de Bary, Morphologie und Physiologie der Pilze, 1886, p. 209.

Hálsskógur [O. D.]; Seyðisfjörður, Hlíðarfjall, Norðtúnga, Borg [P. L.]. — On droppings of ptarmigan, sheep and horses.

123. **S. dicipiens** Winter, Deutsche Sord., p. 28.

Seyðisfjörður [P. L.]; det. O. Rostrup. — Horse-, sheep- and cow-dung.

124. **S. hirta** Hansen, Fungi fimicoli danici, Nat. For. Vid. Medd. 1876, p. 336.

Seyðisfjörður [P. L.]; det. O. Rostrup. — On horse dung.

125. **S. minuta** Fuckel, Symb. myc., II. Nachtr., p. 44.

Hofsfjall [O. D.]. — On horse dung.

126. **S. Winterii** Karsten, Mycologia Fennica II, p. 251.

Hof in Hörgardalur (O. D.). — On horse dung.

Hypocopra Fries.

127. **H. discospora** (Auerswald) Fuckel, Symb. myc., Nachtr. II, p. 43.

On cow dung (Grønlund). — No locality given.

128. **H. fimicola** (Roberge) Saccardo, Syll. fung. I, p. 240.

Gásaeyri, Hof, Hálsskógur [O. D.]. — On horse dung.

H. fimicola (Roberge) Saccardo f. **microspora** Starbäck.

Seyðisfjörður [P. L.], det. O. Rostrup. — On sheep dung. Spores 13—14×6 μ.

129. **H. insignis** (Hansen) Saccardo, Syll. fung. I, p. 243.

Sordaria insignis Hansen, Fungi fimicoli danici, Vid. Medd. fra Nat. For. 1876, p. 334.

Hallgilsstaðafjall [O. D.]. — On sheep dung.

130. **H. microspora** (Plowright) Saccardo, Syll. fung. I, p. 241.

Hörgárdalur [O. D.]. — On horse dung.

131. **H. minima** Saccardo, Syll. fung. I, p. 244.

Sordaria minima Saccardo et Speg., Michelia I, p. 373.

Hofsfjall in Hörgárdalur [O. D.]. — On horse dung.

132. **H. stercoraria** (Sowerby) Saccardo. Rostrup Isl. Svampe 1903, p. 299.

Hof, Hálsskógur [O. D.]. On horse dung.

Delitschia Auerswald.

133. **D. moravica** Niessl, Notiz. üb. Pyrenom., p. 47.

Seyðisfjörður [P. L.], det. O. Rostrup. — On droppings of horses and sheep.

Sporormia De Notaris.

134. **S. minima** Auerswald, Hedwigia VII, p. 66.

Möðruvellir [O. D.]. — On droppings of birds.

135. **S. ambigua** Niessl, Notiz. üb. Pyrenom., p. 97.

Hofsfjall [O. D.]; Seyðisfjörður [P. L.]; det. O. Rostrup. — On droppings of horses and sheep.

136. **S. intermedia** Auerswald, Hedwigia VII, p. 67.

Throughout Iceland. — On droppings of horses, cows, sheep, dogs, and ptarmigan.

137. **S. promiscua** Carestia, in Rabenhorst Fungi Eur., No. 1236.

Hofsfjall [O. D.]. — On droppings of ptarmigan.

138. **S. lageniformis** Fuckel, Symb., p. 242.

Melar [Grønlund]. — On cow dung.

139. **S. Notarisii** Carestia, Rabenhorst: Fungi europaei, No. 976.

Hlíðarfjall near Mývatn [P. L.], det. O. Rostrup. — On ptarmigan droppings.

140. **S. octomera** Auerswald, Hedwigia VII, p. 70.

Hlíðarfjall near Mývatn [P. L.], det. O. Rostrup. — On ptarmigan droppings.

141. **S. commutata** Niessl, Notiz. üb. Pyrenom., p. 464.

Lurkasteinn [O. D.]. — On cow dung.

142. **S. corynespora** Niessl, Notiz. üb. Pyrenom., p. 166.

Seyðisfjörður [P. L.], det. O. Rostrup. — On sheep dung.

Sphaeriaceae.

Coleroa Fries.

143. **C. Alchimillae** (Greville) Winter, Rabenhorst's Kryptogamen-flora, erster Band, II Abtheilung, p. 199.

Hofsfjall, Hraun in Fljót, Hrafnagjá [O. D.]; Markiá Fos [Feddersen]. — On Alchimilla vulgaris.

Leptospora Fuckel.

144. **L. ovina** (Persoon) Fuckel.

Sphaeria ovina Persoon, Synops. meth. fung., p. 71.

Hálsskógur [O. D.]. — On dead branches of Betula pubescens.

Lasiosphaeria Cesari et De Notaris.

145. **L. sorbina var. radiata,** Berlese: Icones Fungorum, Vol. I, tab. 106, fig. 2.

Hálsskógur [O. D.]. — On decorticated dead wood of Betula pubescens.

Herpotrichia Fuckel.

146. **H. nigra** Hartig, Sacc., Syll. fung. IX, p. 858.

Goðaland [H. J.]. — On needles of Juniperis communis.

Bertia De Notaris.

147. **B. Lichenicola** De Notaris, Rabenhorst: Fungi europaei, No. 950.

Reistarárskarð [O. D.]. — On the thallus of Solorina crocea.

Rosellinia Cesati et De Notaris.

148. **R. mammiformis** (Persoon) Winter, Rabh. Krypt. Flora II, p. 226.

Sphaeria mammiformis Persoon, Synops. meth. fung., p. 64.

Hálsskógur [O. D.]. — On birch-wood.

149. **R. subcorticalis** Fuckel, Symbolae, p. 150.

Þingvellír, Hrafnagjá [P. L.]. — On the inner side of the bark of Betula pubescens.

Wallrothiella Saccardo.

150. **W. minutissima** (Crouan) Saccardo? Syll. fung. I, p. 455.

Hlöð in Hörgárdalur [O. D.]. — On the droppings of dogs.

In Isl. Svampe 1903 p. 300 E. Rostrup states the dimensions of the asci as $47 \times 13\,\mu$ and those of the spores as $8-10 \times 5\,\mu$, whereas Ellis and Everhart in North American Pyrenomycetes, p. 255 give the dimensions as $35-40 \times 3.5\,\mu$ for the asci and $3.5-4 \times 2.5\,\mu$ for the spores. These dimensions cannot possibly refer to the same species.

Lizonia De Notaris.

151. **L. abscondita** Johanson, Svampar från Island, 1884.

Eskifjörður [Strömfelt]. — On dead leaves of Dryas octopetala.

Zignoella Saccardo.

152. **Z. ovoidea** (Fries) Saccardo, Michelia I, p. 346.

Syn. Sphaeria ovoidea Fries, Systema II, p. 459.

In a birch copse at Borg [P. L.]. — On dead putrescent branches of Betula pubescens.

Melanomma Fuckel.

153. **M. Pulvis pyrius** (Persoon) Fuckel, Symbolae, p. 160.

Sphaeria Pulvis pyrius Persoon, Synops. meth. fung., p. 86.

N. Iceland: Sluttnes in Mývatn [P. L.] and Hálsskógur [O. D.]. — On dead branches of Salix phylicifolia and on birch-wood.

154. **M. Aspegrenii** (Fries) Fuckel, in Kunze: Mycolog. Hefte II, p. 40 and Symbolae, p. 159.

Þórðarstaðaskógur [O. D.]; Dyrafjörður [N. Hartz]. — On dead branches of Betula pubescens.

155. **M. juniperinum** (Karsten) Saccardo, Michelia I. p. 80.

Sphaeria juniperina Karsten, Mycologia Fennica II, p. 89.

Fornhagagil [O. D.]. — Decorticated branch of Juniperus nana.

Amphisphaeriaceae.

Amphisphaeria Cesati et De Notaris.

156. **A. papillata** (Schumacher) De Notaris, Syll. fung. I, p. 725.

Sphaeria papillata Schumacher, Enumeratio II, p. 161.

Bægisárgil [O. D.]. — On wood of Salix lanata.

Strickeria Körber.

157. **S. Kochii** Körber, Parerga lichenol., 1865, p. 400.

Teichospora Rabenhorstii Saccardo, Syll. fung. II, p. 301.

Laxá near Mývatn [P. L.]. — On dead branches of Salix phylicifolia.

158. **S. obducens** (Fries) Winter.

Sphaeria obducens Fries, Syst. Myc. II, p. 456.

Gásir (O. D.). — On wood washed up from the sea.

159. **S. obducens** (Fries) Winter f. **betulina** n. f.

Þingvellir [P. L.]. — On decorticated spots in branches of Betula pubescens.

The form deviates from *S. obducens* in two respects: 1) The spores are not constricted in the middle. 2) The asci are shorter and broader, in part with biseriate spores.

160. **S. patellarioides** (Saccardo).

Teichospora patellarioides Saccardo, Michelia I, p. 47.

Gásir [O. D.]. — On wood washed up by the sea.

161. **S. Davidssonii** (Rostrup).

Teichospora Davidssonii Rostrup, Isl. Svampe 1903, p. 309.
Hofsfjall [O. D.]. — On buds of Salix lanata.

162. **S. salicina** (Persoon) Gäumann, Vergl. Morph. d. Pilze, p. 261.
Sörlastaðir [O. D.]. — On leaves of Salix phylicifolia.

Lophiostomaceae.

Lophiostoma (Fries) Cesati de Notaris.

163. **L. Juniperi** H. Fabre, Essai sur les Sphériacées de Vaucluse, p. 105, fig. 52.

Fornhagagil [O. D.]. — On branches of Juniperus nana.

Mycosphaerellaceae.

Guignardia Viale et Ravaz.

164. **G. graminicola** (Rostrup).

Laestadia graminicola Rostrup, Grønl. Svampe 1888, p. 548.
Hvammsurð [St. St.]. — On Poa caesia.

165. **G. Potentillae** (Rostrup) Lindau.

Laestadia Potentillae Rostrup, Isl. Svampe 1885, p. 11.
Hvammsfjörður, Seyðisfjörður [A. Feddersen]. — On Potentilla maculata.

166. **G. Oxyriae** (Rostrup).

Laestadia Oxyriae Rostrup. Isl. Svampe, 1903, p. 300.

Krossastaðagil [O. D.]. — On dry stems of Oxyria digyna.

167. **G. Veronicae** (Rostrup).

Laestadia Veronicae Rostrup, l. c., p. 300.

Hestahraun in Þorvaldsdalur [O. D.]. — On living leaves of Veronica alpina.

168. **G. lunulata** (Rostrup).

Laestadia lunulata Rostrup, Bidrag til Kundskaben om Norges Soparter, A. Blytt. Ascomyceter fra Dovre, p. 6.

Hallormstaðir [P. L.]. — On stems and leaves of Erigeron alpina.

Mycosphaerella Johanson.

169. **M. Filicum** (Desmazières) Starbäck, Sacc., Syll. fung. I, p. 532.

Sphaeria Filicum Desmazières (in Ann. sc. nat., II Ser., tom. XIII, p. 187).

The Experimental Station at Reykjavík [P. L.]. — On withered leaves of Dryopteris sp.

170. **M. Equiseti** (Fuckel) Schroeter, Die Pilze Schlesiens, H. 2, p. 341.

Sphaerella Equiseti Fuckel, Symbolae, p. 102.

Hofsfjall [O. D.], Grund near Akureyri [P. L.]. — On withered Equisetum stems.

171. **M. lycopodina** (Karsten) Schroeter, l. c., p. 340.

Sphaerella lycopodina Karsten, Fungi fennici exsicc. No. 569.

Skaptárhraun [St. St.]. — On withered leaves of Lycopodium selago.

172. **M. Juncaginearum** (Lasch) Schroeter, l. c., p. 342.

Dothidea Juncaginearum Lasch, Phaeosphaerella Junc. Sacc. Syll. fung. XI, p. 312. Pictured in Lind, Danish Fungi, plate III, figs. 33—34.

Hof [O. D.]. — On leaves and stems of Triglochin palustris.

173. **M. Tassiana** (De Notaris) Johanson, Svampar från Isl., p. 167.

Sphaerella Tassiana De Notaris, Sferiac. ital., p. 87, taf. XCVIII. Sphaerella pachyasca Rostrup, Grønlands Svampe 1888, p. 552.

Very common on Dicotyledons as well as Monocotyledons.

174. **M. pusilla** (Auerswald) Johanson, l. c., p. 166.

Sphaerella pusilla Auerswald, Mycologia europ., 5. and 6. part, p. 20, Table VI, fig. 80.

Hofsfjall [O. D.]; Fljótsheiði (Grønlund); Hofsós [Strömfelt]. — On Phleum pratense and Carex chordorrhiza.

175. **M. recutita** (Fries) Johanson, l. c., p. 166.

Sphaeria recutita Fries, Syst. Myc. II, p. 524.

Mývatn (Grønlund), Eskifjörður (Strömfelt), Grund near Akureyri, Hálsskógur [P. L.]. — On withered leaves of Festuca rubra, Hierochloa odorata and Agropyrum caninum.

176. **M. lineolata** (Roberge et Desmazières) Schroeter, l. c., p. 339.

Sphaeria lineolata Rob. et Desm., Ann. sc. nat. II Sér. tom. XIX, p. 351.

Fornhagagil [O. D.]. — On withered leaves of grasses.

177. **M. Wichuriana** (Schroeter) Johanson, l. c., p. 166.

Sphaerella Wichuriana Schroeter, Ein Beitrag zur Kenntnis der nordischen Pilze. 58. Jahresber. der schles. Gesellsch., p. 173.

Common on leaves of Carex sp.: C. chordorrhiza, C. rupestris C. rigida, C. vulgaris and C. lagopina.

178. **M. perexigua** (Karsten) Johanson, l. c., p. 166.

Sphaerella perexigua Karsten, Mycologia Fennica II. Pyrenomycetes. p. 54.

Eskifjörður and Hofsós [Strömfelt]. — On Juncus biglumis and Scirpus caespitosus.

179. **M. salicicola** (Fuckel Schroeter, Die Pilze Schlesiens, 2, p. 333.

Sphaerella salicicola Fuckel, Symb., p. 106.

Hof in Hörgárdalur [O. D.]. — On leaves of Salix herbacea.

180. **M. Capronii** Saccardo, Syll. fung. I, p. 487.

Sphaerella salicicola Cooke, Handbook of Br. Fungi, No. 2744.

Hofsfjall [O. D.]. — On leaves of Salix lanata.

181. **M. harthensis** (Auerswald).

Sphaerella harthensis Auerswald, Mycol. europ. Heft V./VI., p. 9. Fig. 37.

Hof in Hörgárdalur [O. D.]. — On leaves of Betula nana.

182. **M. maculiformis** (Persoon) Schroeter, l. c., p. 333.

Sphaeria maculiformis Persoon, Synopsis, p. 90.

Fornhagagil [O. D.], Húsafell [H. J.], Hrafnagjá [P. L.]. — On leaves of Betula pubescens.

183. **M. Polygonorum** (Crié) Lind, The Micromycetes of Svalbard, p. 20.

Hallgilsstaðafjall [O. D.], Viðvík [St. St.]. — On Polygonum viviparum and Rumex Acetosella.

184. **M. isariphora** (Desmazières) Johanson, l. c., p. 164.

Sphaeria isariphora Desm., Ann. sc. nat., II Ser., tome XIX, p. 358. Sphaerella Stellariae Fuckel, Symb., p. 102.

Of common occurrence on many species of the Alsineae: Alsine stricta, Alsine biflora, Alsine verna, Arenaria ciliata, Cerastium alpinum, Cerastium trigynum.

185. **M. tingens** (Niessl), Hedwigia 1883, p. 13.

Möðruvellir [St. St.]. — On Arenaria ciliata.

186. **M. densa** (Rostrup) Lind, Micromyceter fra Åreskutan, Svensk Bot. Tidsskr. 1928, p. 64.

Sphaerella densa Rostrup, Isl. Svampe 1885, p. 225.

Reykjavík [Grønlund]. — On Arenaria ciliata.

187. **M. sibirica** (Thümen).

Sphaerella sibirica Thümen, Beiträge zur Pilz-Flora Sibir. No. 766.

Of common occurrence on Silene acaulis, Silene maritima and Viscaria alpina.

188. **M. fusispora** (Fuckel). in Oudemans: Contributions à la flore mycologique de Nowaja Semlja), Medd. der Konink. Ak. van Wet. 3. Reeks. Deel II., p. 146—161. Amsterdam 1885, p. 151, tab. II, fig. 4.

Hofsfjall [O. D.], Heljardalsheiði (Strömfelt). — On stems of Ranunculus pygmaeus.

189. **M. vulgaris** (Karsten) Schroeter. Die Pilze Schlesiens. 2, p. 337.

Sphaerella vulgaris Karst., Mycologia Fennica II, p. 168.

Sluttnes in Mývatn [P. L.]. — On withered stems of Ranunculus acer.

190. **M. arthopyrenoides** (Auerswald).

Sphaerella arth. Auerswald, Mycol. europ., Heft V and IV, p. 15, fig. 55.

Bíldudalur, Heydalsá [St. St.]. — On Papaver radicatum.

191. **M. Cruciferarum** (Fries).

Sphaeria Cruc. Fries, Syst. Myc. II, p. 525.

Ós in Möðruvallasókn, Hörgárdalur [O. D.]. — On Cardamine pratensis.

192. **M. Parnassiae** (Rostrup).

Sphaerella Parn. Rostrup, Isl. Svampe 1903, p. 302.

Hof in Hörgárdalur [O. D.]. — On stems and sepals of Parnassia palustris.

193. **M. melanoplaca** (Desmazières) Lindau.

This species is described at length by F. Petrak in Hedwigia, Band LXV, p. 231.

Hof in Hörgárdalur [O. D.]. — On withered leaves of Potentilla verna.

194. **M. ootheca** (Saccardo).

Sphaerella ootheca Saccardo, Michelia II, p. 160.

Möðruvellir [St. St.] and Hallgilsstaðafjall [O. D.]. — On Dryas octopetala.

195. **M. Dryadis** (Auerswald).

Sphaerella Dryadis Auerswald, Mycologia europ., Heft V and VI, p. 8.

Berufjörður (Grønlund). — On Dryas octopetala.

196. **M. innumerella** (Karsten) Starbäck, Sacc., Syll. fung. I, p. 506.

Sphaerella innum. Karsten, Mycologia Fennica II, p. 182.

Hestahraun in Þorvaldsdalur [O. D.]. — On withered leaves of Sibbaldia procumbens.

197. **M. Viciae** (Schroeter).

Sphaerella Viciae Schroeter, Ein Beitrag zur Kenntnis der nordischen Pilze, p. 10. — Sacc., Syll. fung. IX, p. 613.

Grafarbakki [O. D.]. — On stems of Vicia cracca.

198. **M. Vulnerariae** (Fuckel) Lind, Danish Fungi, p. 208.

Ascochyta vulneraria Fuckel, Sacc., Syll. fung., III, p. 398.

Hvaleyri in Hafnarfjörður [O. D.], Njarðvík [H. J.]. — On leaves of Anthyllis vulneraria.

199. **M. sp.**

Hrafnagjá, Thingvellir [P. L.]. — On withered stems of Geranium silvaticum.

Perithecia gregarious, small, c. 80 μ in diameter. — Asci cylindrical, $35 \times 4-5$ μ, 8-spored. — Spores uniseptate, colourless, $8-10 \times 2.5$ μ, the uppermost cell slightly broader than the lowermost.

200. **M. rubella** (Niessl) Magnus.

Sphaerella rubella Niessl, Hedwigia 1877, p. 118.

Fornhagagil [O. D.], Barkarnautur [H. J.]. — On withered stems of Angelica silvestris.

201. **M. polyspora** Johanson. Svampar från Island 1884, p. 164.

Eskifjörður (Strömfelt), Möðruvellir [St. St.]. — On dry fruit and peduncles of Loiseleuria procumbens.

202. **M. Gentianae** (Niessl).

Sphaerella Gentianae Niessl, Oesterr. botan. Zeitschr. 1875, p. 128.

Ós in Möðruvallasókn [O. D.]. — On dead stems of Gentiana nivalis.

203. **M. Compositarum** (Auerswald) Schroeter.

Sphaerella Compositarum Auerswald, Mycolog. europ., Heft V./VI., p. 15.

Nollsklif and Hestahraun in Þorvaldsdalur [O. D.]. — On dead stems and leaves of Cirsium arvense and Gnaphalium norvegicum.

204. **M. Hieracii** (Cooke et Massee).

Sphaerella Hieracii Cooke et Massee, Grevillea XV, p. 111.

Hestahraun in Þorvaldsdalur and Víðimýri [O. D.]. — On various species of Hieracium.

205. **M. eriophila** (Niessl).

Sphaerella eriophila Niessl, Neue Kernpilze in Oesterr. bot. Zeitschr. 1875, p. 86.

Hofsfjall [O. D.]. — On dead stems of Erigeron alpinum.

206. **M. Taraxaci** (Karsten) Lind, Micromycetes from North-Western Greenland, Meddel. om Grønland 71. 1926, p. 174.

Sphaerella Taraxaci Karsten, Kgl. Vet. Ak. Förh. 1872, No. 2, p. 106.

Hofsfjall [O. D.]. — Taraxacum officinale.

Ophiobolus Riess.

207. **O. herpotrichus** (Fries) Saccardo, Syll. fung. II, p. 352.

Sphaeria herpotricha Fries, Syst. Myc., vol. II, p. 504.

Lónsleirur and Hofsfjall [O. D.]. — On Carex salina and Deschampsia caespitosa.

208. **O. salicinus** Rostrup, Isl. Svampe 1885, p. 224.

Laugardalur (Grønlund). — Under loose bark on branches of Salix glauca.

209. **O. Cesatianus** (Montagne) Saccardo, Syll. fung. II, p. 339.

Grund Plantation [P. L.]. — On dead stems of Achillea millefolium.

Dilophia Saccardo.

210. **D. Graminis** (Fuckel) Saccardo, Syll. fung. II, p. 357.

Fornhagagil, Hofsfjall [O. D.]. — On withered leaves of Deschampsia caespitosa.

Tichothecium Flotow.

211. **T. pygmaeum** Körber, Parerga lichenol., 1865, p. 467.

Möðruvellir and Hof in Hörgárdalur [O. D.], Reynivellir, Reykjavík and Hafnarfjörður (Grønlund), Sandur in Snæfellsnessyssel [H. J.]. — On Placodium saxicola and Aspicilia gibbosa.

212. **T. gemmiferum** (Taylor) Körber, l. c., p. 468.

Verrucaria gemmifera Taylor, Mackay, Flora hibern. II, p. 95.

Reykjavík and Hafnarfjörður (Grønlund). — On the thallus of several lichens.

Venturia Cesati De Notaris.

213. **V. chlorospora** (Cesati) Karsten.

Sphaeria chlorospora Cesati, Rabenhorst: Fungi europ. Nr. 48.

Common throughout the country. — On leaves of Salix herbacea, S. glauca and S. phylicifolia.

214. **V. ditricha** (Fries) Karsten.

Sphaeria ditricha Fries, Systema mycologicum, vol. II, p. 515.

Staðarhraun (Feddersen), Hallormstaðir [H. J.] and Vífilsstaðahlíd [P. L.]. — On dead leaves of Betula pubescens.

215. **V. caulicola** Rostrup, Isl. Svampe 1903, p. 304.

Hestahraun in Þorvaldsdalur [O. D.]. — On stems of Rumex acetosa.

216. **V. islandica** Johanson, Svampar från Isl. 1884, p. 168.

Eskifjörður (Strömfelt). — On dead leaves of Dryas octopetala.

217. **V. Geranii** (Fries) Winter, Rabh. Krypt. Flora, II, p. 434.

Dothidea Geranii Fries, Syst. Myc., vol. II, p. 558.

The Experimental station at Reykjavík [P. L.]. — On leaves of Geranium silvaticum.

218. **V. Myrtilli** Cooke, Journ. Bot. 1866, p. 245.

Fornhagagil and Hof [O. D.]. — On leaves of Vaccinium uliginosum.

Sphaerulina Saccardo.

219. **S. Potentillae** Rostrup, Isl. Svampe 1885, p. 228.

Seyðisfjörður (Feddersen). — On withered stems and sepals of Potentilla maculata.

220. **S. Diapensiae** Rostrup, Isl. Svampe 1903, p. 306.

Hofsfjall [O. D.]. — On peduncles, sepals and fruits of Diapensia lapponica.

221. **S. intermixta** (Berkeley et Broome) Saccardo, Syll. fung. II, p. 187

Sphaeria intermixta Berkeley et Broome, Not. on British fungi, No. 639.

Reykjavík in a garden [H. J.]. — On branches of a Lonicera sp.

Pleosphaerulina Passer.

222. **P. vitrea** (Rostrup) P. Larsen.

Pleospora vitrea Rostrup, Grønl. Svampe 1891, p. 620.

Möðruvellir [St. St.], Hof [O. D.]. — On Alchimilla alpina.

This species has nothing else in common with species of *Pleospora* than the many-celled spores. It belongs to the genus *Pleosphaerulina*. Cp. the herbarium specimen in Rostrup's collection of Icelandic Fungi in the Botanical Museum of Copenhagen.

Physalospora Niessl.

223. **P. montana** Saccardo, Michelia II, p. 378.

Hallormstaðir [P. L.]. — On dead leaves of Trisetum spicatum.

224. **P. Festucae** (Libert) Saccardo, Michelia I, p. 27.

Kollafjardarnes. — On Festuca rubra.

225. **P. Potentillae** Rostrup, Grønl. Svampe 1888, p. 548.

Hof [O. D.]. — On Potentilla maculata.

Massariaceae.

Massarina Saccardo.

226. **M. Dryadis** Rostrup, Grønl. Svampe 1888, p. 560.

Hörgárdalur [O. D.], Egilsstaðir in Vopnafjörður [St. St.]. — On dead leaves of Dryas octopetala.

Massaria De Notaris.

227. **M. Thalictri** (Rostrup) Lind.

Micromyceter fraÅreskutan,Svensk Botanisk Tidskrift, 1928, p. 67.

Lizonia Thalictri Rostrup, Grønl. Svampe 1888.

Reykjahlíd near Mývatn [P. L.]. — On dead stems of Thalictrum alpinum.

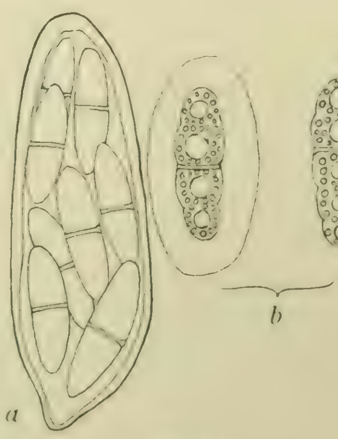


Fig. 2.
Massaria Thalictri.
a. Ascus with immature spores × 333.
b. 2 mature spores × 333

Gnomoniaceae.

Gnomonia Cesati et De Notaris.

228. **G. campylostyla** Auerswald, Mycol. europ., Heft V. VI., p. 25.

Gullfoss near Hvítá [Feddersen], Norðtúnga [P. L.]. — On dead leaves of Betula nana and B. pubescens.

229. **G. setacea** (Persoon) Cesati et De Notaris, Schema sferiac. p. 58.

Sphaeria setacea Persoon, Usteri, Ann. d. Bot. St. 11, p. 25.

Norðtúnga, Þingvellir and Vífilsstaðahlíd [P. L.]. — On dead leaves of Betula pubescens.

230. **G. pleurostyla** Auerswald, Mycol. europ. Heft V./VI., p. 28.

Gullfoss near Hvítá (Feddersen). — On dead leaves of Salix herbacea.

231. **G. vagans** (Johanson) Rostrup, Isl. Svampe 1903, p. 303.

Gnomoniella vagans Johanson, Svampar från Isl. 1884, p. 168.

Eskifjörður (Strömfelt). — On stalks of leaves and flowers of Dryas octopetala.

232. **G. borealis** Schroeter, Die Pilze Schlesiens, 2, p. 391.

Reykjahlíd near Mývatn in Storugjá [P. L.]. — On dead stems of Geranium silvaticum.

Clypeosphaeriaceae.

Hypospila Fries.

233. **H. groenlandica** Rostrup, Grønl. Svampe 1888, p. 561.

Hrafnagjá on Þingvellir [P. L.]. — On dead leaves of Salix glauca.

234. **H. rhytismoides** (Babington) Niessl (in Winter, Fungi europ. No. 3261).

Laestadia rhyt. Saccardo, Syll. fung. I, p. 424.

Vatnsdalshólar [St. St.], Hofsfjall [O. D.], Berufjörður (Grønlund) and Eskifjörður (Strömfelt). — On dead leaves of Dryas octopetala.

Linospora Fuckel.

235. **L. Capreae** (De Candolle) Fuckel, Symbol. p. 124.

Sphaeria Capreae De Candolle, Flore franç. VI, p. 130.

Hofsfjall, Hestahraun in Þorvaldsdalur [O. D.], Herðubreiðarlindir (Thoroddsen). — On dead leaves of Salix glauca and S. lanata.

236. **L. insularis** Johanson, Svampar från Isl. 1884, p. 171.

Eskifjörður (Berlin). — On dead leaves af Salix lanata.

237. **L. caudata** nov. spec.

Grund Plantation south of Akureyri [P. L.]. — On dead leaves of Salix phylicifolia.

Pseudostroma papillary, 0.5—1 mm broad, enclosing 1 perithecium whose elongated orifice protrudes from the stroma, now laterally, now

centrally. — Asci cylindrical, short-stalked, 80—100 × 6—7 μ, 8-spored. Spores parallel, needle-shaped, 50 × 1—2 μ, provided — sometimes at both ends, but more often only at one end — with a 20—30 μ long, straight or curved appendage, 0.5—1 μ broad, in some few spores 2 or 3 such appendages at the same end.

Distinguished by the appendages of the spores.

Valsaceae.

Valsa (Scopoli) Fries.

238. **V. betulina** Nitschke, Pyrenomycetes germanici, p. 219.

Fornhagagil [O. D.], Holm in Selsundslækur (Feddersen). — On dead branches of Betula pubescens.

239. **V. polyspora** Nitschke, Pyrenom. germ., p. 238.

Vífilsstaðahlíd [P. L.]. — On dead branches of Betula pubescens.

Diaporthe Nitschke.

240. **D. salicella** (Fries) Saccardo, Syll. fung. I, p. 622.

Sphaeria salicella Fries, Syst. Myc., vol. II, p. 377.

Sluttnes in Mývatn [P. L.]. — On dead branches of Salix phylicifolia.

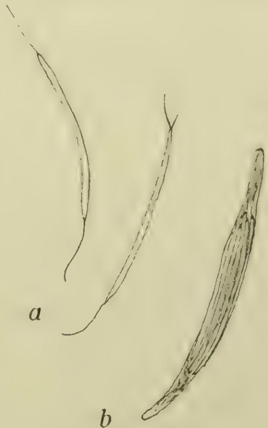


Fig. 3.
Linospora caudata n. sp.
a. 2 spores × 500.
b. Ascus with spores × 500.

241. **D. aristata** (Fries) Karsten, Mycologia Fennica II, p. 112.

Sphaeria aristata Fries, Syst. Myc. II, p. 363.

Hálsskógur and Hof [O. D.], Hallormstaðir, Norðtúnga and Þingvellir [P. L.]. — On living and dead branches of Betula nana and Betula pubescens — a facultative parasite.

242. **D. muralis** Spegazzini, Michelia I, p. 458. Saccardo, Syll. fung. I, p. 655.

Asarnir in Galmarströnd [O. D.]. — On dead stems of Sedum villosum.

Fenestella Tulasne.

243. **F. princeps** Tulasne, Selecta fungorum carpologia II, p. 207.

Fornhagagil [O. D.]. — On dead branches of Salix lanata.

244. **F. tumida** (Persoon) Saccardo, Syll. fung. II, p. 329.

Sphaeria tumida Persoon, Synopsis methodica fungorum, p. 41.

Hálsskógur [O. D.]. — On dead branches of Betula pubescens.

Melanconidaceae.

Cryptospora Tulasne.

245. **C. Betulae** Tulasne, Sel. fung. carp. II, p. 149.

Húsafellsskógur [O. D.]. — On dead branches of Betula pubescens.

Valsaria Cesati et De Notaris.

246. **V. Niesslii** (Winter) Saccardo, Syll. fung. I, p. 749.

Phaeosperma Niesslii Winter, Hedwigia 1874, p. 131.

Hálsskógur [O. D.]. — On the bark of Betula pubescens.

Melanconis Tulasne.

247. **M. stilbostoma** (Fries) Tulasne, Sel. fung. carp. II, p. 119.

Sphaeria stilbostoma α Fries, Syst. Myc. II, p. 403.

Norðtúnga [P. L.]. — On dead branches of Betula pubescens.

Pseudovalsa Cesati et De Notaris.

248. **P. lanciformis** (Fries) Cesati et De Notaris.

Sphaeria lanciformis Fries, Syst. Myc., vol. II, p. 362.

Fornhagagil [O. D.]. — On dead branches of Betula pubescens.

Diatrypaceae.

Diatrype Fries.

249. **D. bullata** (Hoffmann) Fries, Summa Veg. Scand. p. 385.

Slúttnes in Mývatn [P. L.]. — On dead branches of Salix phylicifolia.

Diatrypella Cesati et De Notaris.

250. **D. verrucaeformis** (Ehrhart) Nitschke, Pyrenom. germ., p. 76.

Sphaeria verrucaeformis Ehrhart, Plant. crypt. exsicc. No. 280 sec. Nitschke.

Gilsbakki in Austurdalur [O. D.], Egilsstaðir [H. J.]. — On dead branches of Betula pubescens.

251. **D. favacea** (Fries) Nitschke, Pyrenom. germ., p. 77.

Sphaeria favacea Fries, Syst. Myc., vol. II, p. 354.

Skríða in Hörgárdalur [O. D.], Egilsstaðir [H. J.]. — On dead branches of Betula pubescens.

Calosphaeria Tulasne.

252. **C. ciliatula** (Fries) Karsten.

Sphaeria ciliatula Fries, Syst. Myc., vol. II, p. 406.

Norðtúnga and Þingvellir [P. L.]. — On dead branches of Betula pubescens.

253. **C. pusilla** (Wahlenberg) Karsten, Mycolog. fennica II, p. 157.

Sphaeria pusilla Wahlenberg, Flora Lappon., p. 520.

Þingvellir [P. L.]. — On the inner side of pieces of bark of Betula pubescens.

Xylariaceae.

Hypoxylon Bulliard.

254. **H. fuscum** (Persoon) Fries, Summa Veg. Scand., p. 384.

Sphaeria fusca Persoon, Usteri, Neue Anal. d. Bot. t. II. 5, p. 22.

Hálsskógur [O. D.]. — On dead branches of Betula pubescens.

Dothideaceae.

Mazzantia Montagne.

255. **M. Galii** (Fries) Montagne.

Sphaeria Galii Fries, Elenchus fungorum II, p. 105.

Almannagjá on Þingvellir [P. L.]. — On dead stems of Galium verum.

Dothidella Spegazzini.

257. **D. Laminariae** Rostrup, Mykologiske Meddelelser V, Botanisk Tidsskrift vol. 19, 1894, p. 213.

Common on sea coasts as well as in fiords. — On the stems of Laminaria saccharina, L. digitata and Alaria esculenta.

257. **D. betulina** (Fries) Saccardo.

Xyloma betulinum Fries, Observ. mycol. I, p. 198.

Húsafellsskógur, Hof in Hörgardalur [O. D.], Vallanes [H. J.]. — On dead leaves of Betula pubescens and B. nana.

258. **D. thoracella** (Fries) Saccardo.

Sphaeria thoracella Rutström, Fries, Syst. Myc. II, p. 558.

Hraunatindur near Arnarfell [St. St.]. — On dead leaves of Rhodiola rosea.

259. **D. Angelicae** (Fries) Rostrup.

Dothidea Angelicae Fries, Syst. Myc. II, p. 561.
Fusicladium Angelicae (Fries) Lind, Danish Fungi, p. 521.

Skriða in Hörgárdalur [O. D.], Fornhagagil and Marðarnúpsgil [St. St.]. — On Archangelica officinalis and Angelica silvestris.

Phyllachora Nitschke.

260. **P. Graminis** (Persoon) Fuckel, Symbol., p. 216.

Sphaeria Graminis Persoon, Observat. mycol. I, p. 18.

Fornhagagil and Hof [O. D.], Sandfell [H. J.], Reykjavík (Strömfelt). — On leaves of Agrostis vulgaris and A. canina.

261. **P. Poae** (Fuckel) Saccardo.

Scirrhia Poae Fuckel, Symbolae, p. 221.

Barkarnautur [H. J.]. — On dead leaves of Poa caesia.

Hypodermataceae.

Lophodermium Chevallier.

262. **L. pinastri** (Schrader) Chevallier, Flore paris. I, p. 430.

Hysterium pinastri Schrader, Journ. Bot. II, p. 69, tab. 3, fig. 4.

The plantation on Þingvellir [P. L.]. — On needles of Pinus montana.

263. **L. juniperinum** (Fries) De Notaris.

Hysterium juniperinum Fries (pinastri β), Syst. Myc. II, p. 588.

Fornhagagil [O. D.], Kúadalur (Grønlund). — On needles of Juniperus nana.

264. **L. arundinaceum** (Schrader) Chevallier, Flore paris. I, p. 435.

Hysterium arundinaceum Schrader, Journ. Bot. II, p. 68, tab. 3, fig. 3.

Fairly common on Graminaceae throughout the country, viz. on Nardus, Anthoxanthum, Elymus, Trisetum spicatum, Calamagrostis stricta, Hierochloë odorata, Festuca ovina, F. rubra, Poa alpina, P. caesia, P. nemoralis.

L. arundinaceum (Schrader) Chevallier **var. alpinum** Rehm, Rabenhorst Kryptogamenflora III, p. 46.

Víðidalur [P. L.], — On dead leaves of Elymus arenarius.

265. **L. caricinum** (Roberge) Duby.

Hysterium c. Roberge, No. 71 in Ann. sc. nat., III. Sér., t. 8, p. 180.

Möðruvellir [St. St.], Hofsfjall [O. D.], Grund near Akureyri and Borg near Borgarnes [P. L.]. — On dead leaves of Carex festiva, C. capillaris, Elyna Bellardi, Eriophorum augustifolium.

266. **L. versicolor** (Wahlenberg) Schroeter, Jahrbuch d. schles. Ges. für vaterl. Cultur, Breslau 1888, p. 266.

Grund Plantation near Akureyri [P. L.]. — On dead leaves of Salix phylicifolia.

267. **L. maculare** (Fries) De Notaris.

Hysterium maculare Fries, Syst. Myc. II, p. 592.

Hofsfjall [O. D.]. Haukadalur and Gullfoss near Hvítá (Feddersen). — On dead leaves of Vaccinium uliginosum and Salix glauca.

268. **L. petiolicolum** Fuckel, Symbolae, p. 255.

Hestahraun in Þorvaldsdalur [O. D.]. — On petioles of Sibbaldia procumbens.

Hysteriaceae.

Lophium Fries.

269. **L. dolabriforme** Wallroth, Sacc., Syll. fung. II, p. 800.

Húsafellsskógur [O. D.]. — On dead branches of Betula pubescens.

Microthyriaceae.

Myiocopron Speggazzini.

270. **M. calamagrostidis** E. Rostrup (in mscr.).

Peritheciis membranaceis, dimidiato-scutatis, superficialibus, sparsis, radiato-striatis, margine eximie fimbriatis, minutissimis, usque ad 0,3 mm diametro, ostiolo latiusculo pertusis.
Ascis clavatis, 37—40 μ l., 6—7 μ cr., copiose paraphysatis. Sporis distichis, oblongis 8—10 l., 2 μ cr., guttulatis.

Hraun [O. D.]. — On Calamagrostis stricta.

Microthyrium Desmazières.

271. **M. Rubi** Niessl, Kunze: Fungi selecti, No. 379.

Almannagjá on Þingvellir (Feddersen), Hálsskógur and Vífilsstaðahlíð [P. L.]. — On dead stems of Rubus saxatilis.

Phacidiaceae.

Rhytisma Fries.

272. **R. salicinum** Fries, Vetensk. Akad. Handl. 1819, p. 104.

Common throughout the country on dead leaves of Salix: Salix herbacea, S. glauca, S. lanata, S. phylicifolia.

273. **R. Bistortae** (De Candolle) Rostrup, Grønl. Svampe 1888, p. 542.

Xyloma Bistortae De Candolle, Flor. fr. VI, p. 153.

Grímsey, Hof, Stóri Núpur [O. D.]. — On leaves of Polygonum viviparum.

Coccomyces De Notaris.

274. **C. quadratus** (Schmidt & Kunze) Karsten, Myc. Fenn. I, p. 255.
Phacidium quadratus Schmidt & Kunze, Myc. Hefte I, p. 41.
Kálfsdalur [St. St.]. — On dead stems of Vaccinium Myrtillus.

Sphaeropeziza Saccardo.

275. **S. Arctostaphyli** (Karsten) Rehm, Annal. myc. V, p. 231.
Phacidium Arctostaphyli Karsten.
Trochila phacidioides Karsten, Myc. Fenn. I, p. 249.
Möðruvallafjall [St. St.], Hofsfjall [O. D.]. — On dead leaves of Diapensia lapponica.

Cryptomyces Greville.

276. **C. maximus** (Fries) Rehm, Rabh Krypt. Flora III, p. 107.
Rhytisma maximum, Fries, Syst. Myc. II, p. 566.
Kollafjarðarnes (G. Guðmundsson). — On twigs and aments of Salix herbacea.

Phacidium Fries.

277. **P. repandum** Fries, Syst. Myc. II, p. 578.
Húsafellsskógur [O. D.], Hvammur (Páll Gíslason). — On living leaves of Galium boreale.

Clithris Fries.

278. **C. degenerans** (Fries) Rehm, Rabh. Krypt. Flora III, p. 104.
Hysterium degenerans Fries, Kunze, Mycolog. Hefte II, p. 60.
Sporomega degenerans Corda, Iconum fungorum V., pp. 60, 69, 70.
Hof [O. D.]. — On dead stems of Vaccinium uliginosum.

Pseudophacidium Karsten.

279. **P. degenerans** Karsten, Revisio monographica ascom. Fenn. 1885, p. 157.
Möðruvellir [O. D.]. — On dead stems of Vaccinium Myrtillus.

Tryblidiaceae.

Heterosphaeria Greville.

280. **H. Patella** (Tode) Greville.
Sphaeria penetrans α patella Tode, Fungi Mecklenburgenses II, p. 45.
Mafahlíð, Vestmannaeyjar, Drangshlíð, Streiti [H. J.]. — On dead stems of Angelica silvestris and Archangelica officinalis.

Scleroderris Fries.

281. **S. aggregata** (Lasch) Rehm, Rabh. Krypt. Flora III, p. 212.

Sphaeria aggregata Lasch, Bot. Zeit., 1857, p. 428.

Grund Plantation south of Akureyri [P. L.]. — On dead stems of Rhinanthus crista-galli.

Stictidaceae.

Schizoxylon Persoon.

282. **S. Berkeleyanum** (Durieu et Léveillé) Fuckel, Symbolae, p. 251.

Stictis Berkeleyanum Durieu et Léveillé, Flor. alg. tab. 89, fig. 8.

Rhaun in Öxnadalur [O D.]. — On dead stems of Rhodiola rosea.

Cryptodiscus Corda.

283. **C. pallidus** (Persoon) Corda.

Stictis pallida Persoon, Obs. myc. II, p. 74.

Húsafellsskógur [O. D.]. — On wood of Betula pubescens.

Propolis Fries.

284. **P. faginea** (Schrader) Karsten, Myc. Fenn. I, p. 244.

Hysterium fagineum Schrader, Botan. Journ. II, p. 68.

Common in all birch copses. — On wood of Betula pubescens.

Naevia Fries.

285. **N. atrosanguinea** (Rostrup) Saccardo.

Trochila atros. Rostrup, Isl. Svampe 1885, p. 224.

Svínadalur. Hvalfjörður (Grønlund). — On Carex rigida and Carex vulgaris.

286. **N. diminuens** (Karsten) Rehm, Rabh. Krypt. Flora III, p. 142.

Trochila diminuens Karsten, Myc. Fenn. I, p. 248.

Sörlatúngugil, Hofsfjall, Hestahraun [O. D.], Eyjafjörður (Strömfelt), Almannagjá [P. L.]. — On dead leaves of Carex atrata, C. capitata, C. rigida, Luzula arcuata.

287. **N. ignobilis** (Karsten) Rehm, Rabh. Krypt. Flora III, p. 142.

Trochila ignobilis Karsten, Myc. Fenn. I, p. 248.

Of common occurrence on the following species. Monocotyledons: Carex atrata, C. rigida, C. rostrata, C. vaginata and Cobresia scirpina.

288. **N. fuscella** (Karsten) Lind, Danish Fungi, p. 136.

Trochila fuscella Karsten, Mycologia Fennica I, p. 248.
Phacidium fuscellum Karsten, Revisio monographica .... Acta Soc. Fauna et Flora Fennica II, Nr. 6, p. 160.

Norðtúnga, Hvalfjörður, Þingvellir (Grønlund), Vidvík [St. St.], Hofsvatn near Tvídægra (Thoroddsen). — On Carex hyperborea, C. rigida, C. vulgaris, C. pulla.

289. **N. pusilla** (Libert) Rehm, Rabenhorst Kryptogamenflora III, p. 118.

Trochila juncicola Rostrup (sensu Lind).

Hof and Hofsfjall [O. D.]. — On Juncus filiformis, J. balticus, Luzula multiflora.

Ocellaria Tulasne.

290. **O. chrysophaea** (Persoon) Quélet, Enchir. fung., Paris 1886, p. 332.

Peziza chrysophaea Persoon, Synops. meth. fung., p. 674.

Húsafellsskógur [O. D.]. — On wood of Betula pubescens.

Agyriaceae.

Agyrium Fries.

291. **A. rufum** (Persoon) Fries, Syst. Myc. II, p. 232.

Stictis rufa Persoon, Obs. myc. II, p. 74.

Húsafellsskógur [O. D.], Þingvellir (Feddersen). — On wood of Betula pubescens.

Celidiaceae.

Celidium Tulasne.

292. **C. varians** (Davies) Arnold, Flora 1862, p. 312.

Lichen varians Davies, Trans. Linn. Soc. II, p. 284.

Grímsey [O. D.]. — On Lecanora sordida.

Patellariaceae.

Durella Tulasne.

293. **D. melanochlora** (Sommerfelt) Rehm.

Patellaria melanochlora (Som.) Karsten, Myc. fenn. I, p. 233.

Möðruvellir [O. D.]. — On dry wood.

Scutula Tulasne.

294. **S. Stereocaulorum** (Anzi) Körber, Parerg. lich., p. 26.

Lecidea Stereocaulorum Anzi, Manip. lich., p. 26.

Vallanes [H. J.]. On the thallus of Stereocaulon sp.

Karschia Körber.

295. **K. scabrosa** (Acharius) Rehm, Rabh. Krypt. Flora III, p. 350.

Lecidea scabrosa Acharius, Meth. lichen., p. 48.

Skútustaðir near Mývatn [O. D.], Eiðar in E.-Icel. [H. J.].

In E. Rostrup »Islands Svampe«, Botanisk Tidsskrift, 25. vol, p. 313, where this fungus is mentioned, no host plant is given. Nor have I been able to find Karschia scabrosa in the Collection of Icelandic Fungi at the Botanical Museum of Copenhagen; but as two localities are given and E. Rostrup states that he has seen specimens of the fungus from both localities, there can be no doubt that the statement is correct.

Abrothallus De Notaris.

296. **A. Parmeliarum** (Sommerfelt) Nylander.

Lecidea Parmeliarum Sommerfelt, Lich. lapp. suppl., p. 176.
Abrothallus Smithii Tulasne, Mém. lich. in Ann. sc. nat. sér. III, tome XVII, Paris 1852, p. 113.

Berufjörður. — On the thallus of Parmelia saxatilis.

Patellaria Fries.

297. **P. atrata** (Hedwig) Fries, Syst. Myc. II, p. 160.

Lichen atratus Hedwig, Spec. musc. frond. II, p. 61.

Þingvellir (Feddersen). — On wood of Betula pubescens.

298. **P. Bagnisiana** (Saccardo) Rehm.

Lecanidion Bagnisianum Saccardo, Syll. fung. VIII, p. 799.

Húsafellsskógur [O. D.]. — On wood of Betula pubescens.

Dermateaceae.

Godronia Mougeot.

299. **G. Urceolus** (Albertini et Schweinitz) Karsten, Revisio monogr., p. 144.

Peziza Urceolus Albertini et Schweinitz, Conspectus fungorum in Lusatiae superioris agro Niskiensi crescentium, Leipzig 1805, p. 332.

Birch copse near Norðtúnga [P. L.]. — On thin dead branches of Betula pubescens.

300. **G. pusiola** Karsten, Myc. Fenn. I, p. 214.

Hvammur (Grønlund). — On Nardus strictus.

Tympanis Tode.

301. **T. saligna** Tode, Fungi Mecklenburgenses selecti I, p. 24, t. IV, f. 37.

Hálsskógur [O. D.]. — On a branch of Salix phylicifolia.

302. **T. tumida** (Person) Saccardo, Syll. fung. II, p. 329.

Sphaeria tumida Persoon, Synops. meth. fung., p. 41.

Hálsskógur [O. D.]. — On dead branches of Betula pubescens.

Mollisiaceae.

Tapesia Persoon.

303. **T. fusca** (Persoon) Fuckel, Symbolae, p. 302.

Peziza fusca Persoon, Observationes mycologicae I, p. 29.

Hálsskógur and Hlöð [O. D.]. — On branches of Betula nana and B. pubescens.

Mollisia Fries.

304. **M. advena** Karsten, Fungi in insulis Spetsbergen et Beeren Eiland collecti. Öfv. af Kgl. Vet. Ak. Förh. 1872, No. 2, p. 95. Stockholm 1872.

Gálmaströnd [O. D.], Biellarhöll [St. St.]. — On Eriophorum augustifolium.

305. **M. graminis** (Desmazières) Karsten, Hedwigia 1893, p. 60.

Common throughout the country on many different grasses.

306. **M. caesia** (Fuckel) Saccardo, Syll. fung. VIII, p. 340.

Niptera caesia Fuckel, Symbolae, Nachtr. I, p. 47.

Vífilsstaðahlíð [P. L.]. — Ou dead branches of Betula pubescens.

307. **M. Schumacheri** (Fries) Rehm, Annal. Myc. vol. V, p. 545.

Peziza Schumacheri Fries, Syst. Myc. II, p. 98.

Hálsskógur [O. D.]. — On wood of Betula pubescens.

308. **M. melaleuca** (Fries) Saccardo, Syll. fung. VIII, p. 337.

Peziza melaleuca Fries, Syst. Myc. II, p. 150.

The plantation on Þingvellir [P. L.]. — On dead branches of Sorbus suecica.

309. **M. atrata** (Persoon) Karsten, Myc. Fenn. I, p. 200.

Peziza atrata Persoon, Synops. meth. fung., p. 669.

Helgadalsheiði (Strömfelt), Hraun in Fljót [O. D.], Gulfoss (Feddersen), Storugiá near Reykjahlíð [P. L.]. — Grows on dead stems of many different plants: Geranium silvaticum, Ranunculus glacialis, R. acer, Bartsia alpina, Hieracium prenanthoides.

310. **M. cinerea** (Batsch) Karsten, Myc. Fenn. I, p. 189.

Peziza cinerea Batsch, Contr. myc. I, p. 196.

Common throughout the country on dead stems of many different plants.

Niptera Fries.

311. **N. ramealis** Karsten, Revisio monogr. 1885, p. 152.

Hálsskógur [O. D.]. — On dead branches of Betula pubescens.

Belonidium Montagne et Durien.

312. **B. iuncisedum** (Karsten) Rehm, Sacc., Syll. fung. VIII, p. 347.

Mollisia junciseda Karsten, Myc. fenn. I, p. 189.

Jökulsá near Möðrudalur [P. L.], Nýgræður [St. St.]. — On dead stems of Juncus balticus.

313. **B. rufum** Schroeter, Die Pilze Schlesiens 2. H., p. 109.

Hallormstaðir [P. L.]. — On dead leaves of Trisetum spicatum.

314. **B. Laschii** Rehm, Rabh. Krypt. Flora III, p. 570.

Jökulsá near Víðidalur [P. L.]. — On dead stems of Juncus balticus.

Fabraea Saccardo.

315. **F. Cerastiorum** (Wallroth) Rehm, Rabh. Krypt. Flora III, p. 600.

Phlyctidium Cerastiorum Wallroth, Flor. crypt. germ. II, p. 465.

Fornhagagil [O. D.]. — On living leaves and stems of Cerastium vulgatum.

316. **F. Ranunculi** (Fries) Karsten, Revisio monogr. asc. Fenn. 1885, p. 161.

Dothidea Ranunculi Fries, Syst. Myc. II, p. 562.

Hestahraun in Þorvaldsnalur [O. D.]. — On living leaves of Ranunculus acer.

317. **F. confertissima** Karsten, l. c., p. 162. — Sacc., Syll. fung. VIII, p. 736.

Sörlatúngugil [O. D.], Vífilsstaðahlíð [P. L.]. — On dead stems and leaves of Geranium silvaticum.

Pyrenopeziza Fuckel.

318. **P. Rubi** (Fries) Rehm, Rabh. Krypt. Flora III, p. 611.

Exipula Rubi Fries, Syst. Myc. II, p. 190.

The Experimental Station at Reykjavík [P. L.]. — On dead branches of Rubus idaeus.

Orbilia Fries.

319. **O. coccinella** (Sommerfelt) Karsten, Myc. Fenn. I, p. 98.

Peziza coccinella Sommerfelt, Suppl. Flor. Lappon., p. 276.

Þingvellir [P. L.]. — On bark and wood of dead branches of Betula pubescens.

320. **O. auricolor** Saccardo, Syll. fung. VIII, p. 625.

Hrafnagjá on Þingvellir [P. L.]. — On wood of Betula pubescens.

Calloria Fries.

321. **C. erythrostigmoides** Rehm, Rabh. Krypt. Flora III, p. 464.

Hallgilsstaðafjall [O. D.]. — On dead leaves of Cerastium alpinum.

322. **C. minutissima** Rostrup, Grønl. Svampe 1888, p. 537.

Skriða in Hörgárdalur [O. D.]. — On Archangelica officinalis.

Helotiaceae.

Chlorosplenium Fries.

323. **C. aeruginosum** (Oeder) De Notaris.

Helvella aeruginosnm Oeder, Flora danica, tab. 534, fig. 2; Vahl, Flora danica, tab. 1260, fig. 1.

Recorded in Zoëga's »Flora Islandica«.

Sclerotinia Fuckel.

324. **S. Vahliana** Rostrup, Grønl. Svampe 1891, p. 607.

Möðruvellir [St. St.]; Framnes near Dýrafjörður (Ostenfeld); Norðtúnga [P. L.]. — On tufts of Carex and Eriophorum on swampy ground. The peasized sclerotia are often seated in the axils of the leaves, covered by the leaf-sheaths.

325. **S. Fuckeliana** (De Bary) Fuckel, Symbolae, p. 330.

Peziza Fuckeliana De Bary, Morph. Phys. der Pilze, p. 30, fig. 12, p. 238.

The sclerotia and conidia (*Botrytis cinerea*) are of extremely common occurrence throughout the country on many different host plants, as: Rumex domesticus, Polygonum aviculare, Viscaria alpina, Sedum villosum, Saxifraga nivalis, Geranium silvaticum, Geum rivale, Alchemilla alpina, Sibbaldia procumbens, Gentiana campestris, Pedicularis flammea, Hieracium sp., Gnaphalium norvegicum.

Dasyscypha Fries.

326. **D. diminuta** (Roberge et Desmazières) Saccardo, Syll. fung. VIII, p. 449.

Peziza diminuta Roberge et Desmazières, Annales sci. nat. 1847, vol.VII, p. 185.

Hanastaðir (N. Iceland) [O. D.]. — On dead stems of Juncus balticus.

327. **D. variecolor** (Fries) Lind, Danish Fungi, p. 115.

Peziza variecolor Fries, Syst. Myc. II, p. 100.

Möðruvellir, Hofsfjall [O. D.]. — On old woodwork.

Lachnella Fries.

328. **L. corticalis** (Persoon) Fries, Sum. Veg. Scand., p. 365.

Peziza corticalis Persoon, Tentamen dispositionis methodicae fungorum, p. 34.

Fornhagagil, Þrastarhólsgljúfur [O. D.]. — On dead branches of Salix lanata.

329. **L. flammea** (Albertini et Schweinitz) Fries, Sum. Veg. Scand., p. 365.

Pezixa flammea Albertini et Schweinitz, Conspectus fungorum, p. 319.

Hálsskógur, Fornhagagil [O. D.], Egilsstaðir [P. L.]. — On Betula pubescens.

Lachnum Retzius.

330. **L. patens** (Fries) Karsten, Myc. Fenn. I, p. 179.

Peziza clandestina *β* patens Fries, Syst. Myc. II, p. 94.

Þorvaldsdalur, Hofsfjall [O. D.]. — On Phleum pratense, Phl. alpinum and Poa nemoralis.

331. **L. calycioides** Rehm, Rabh. Krypt. Flora III, p. 909.

Eyjafjörður near Akureyri [P. L.]. — On dead stems of Juncus trifidus.

332. **L. bicolor** (Bulliard) Karsten, Myc. Fenn. I, p. 172.

Peziza bicolor Bulliard, Histoire des Champignons de la France, p. 242.

Þingvellir, Borg [P. L.], Hálsskógur, Hofsfjall [O. D.], Eyjólfsstaðir [H. J.]. — On wood of Betula pubescens, B. nana.

333. **L. virgineum** (Batsch) Karsten, Myc. Fenn. I, p. 169.

Peziza virginea Batsch, Elenchus fungorum, p. 125.

Húsafellsskógur, Hálsskógur [O. D.]. — On wood of Betula pubescens.

334. **L. niveum** Karsten, Myc. fenn. I, p. 168.

Krossastaðagil [O. D.]. — On dead branches of Salix lanata.

Erinella Saccardo.

335. **E. callimorpha** (Karsten) Rehm, Rabh. Krypt. Flora III, p. 1241.

Lachnum callimorphum Karsten, Mycologia fennica I, p. 173.

Miðfjarðarháls [O. D.], Laugarnes [P. L.]. — On dead leaves of Eriophorum angustifolium.

Helotium Fries.

236. **H. rhodoleucum** Fries, Sum. Veg. Scand., p. 335.

Hof in Hörgárdalur [O. D.], Eskifjörður (Strömfelt). — On dead stems of Equisetum sp.

337. **H. citrinum** (Hedwig) Fries, Sum. Veg. Scand., p. 335.

Octospora citrina Hedwig, Species muscorum frondosorum II, tab. 8 C.

Húsafellskógur [O. D.], Bæjarstaður (Buchwald). — On wood of Betula pubescens.

338. **H. virgultorum** (Vahl) Karsten, Myc. Fenn. I, p. 109.

Peziza virgultorum Vahl, Flora danica, tab. 1016, f. 2.

Hálsskógur, Krossastaðagil, Möðruvellir [O. D.]. — On dead branches of Betula pubescens and Salix lanata.

339. **H. scutula** (Persoon) Karsten, Myc. Fenn. I, p. 110.

Peziza scutula Persoon, Mycologia europaea I, p. 284.

Hestahraun in Þorvaldsdalur [O. D.]. — On dead stems of Gnaphalium norvegicum.

Phialea Fries.

340. **P. cyathoidea** (Bulliard) Gillet, Discom. franç., p. 106.

Peziza cyathoidea Bulliard, Champignons de la France, p. 250, t. 416, f. 3.

Möðruvellir, Þorvaldsdalur, Grímstaðir near Mývatn, Hörgárdalur, Hraunsvatn [O. D.]; The Experimental Station at Reykjavík, Vífilsstaðahlíð [P. L.]. — On dead stems of: Rumex domesticus, Oxyria, Ranunculus acer, Angelica silvestris, Archangelica officinalis, Carum carvi, Gnaphalium norvegicum, Silene vulgaris.

341. **P. grisella** Rehm? Rabh. Krypt. III, p. 737.

Lachnella grisella Phillips, Grevillea 18, p. 84.

Hestahraun in Þorvaldsdalur [O. D.]. — On a decorticated branch.

Is is very doubtful whether this fungus really belongs to the above species. It is not included in the Collection of Icelandic Fungi at the Botanical Museum of Copenhagen, nor is the substratum recorded the usual one, since the fungus generally grows on the under side of fern leaves.

342. **P. dolosella** (Karsten) Saccardo, Syll. fung. VIII, p. 275.

Almannagjá (Þingvellir) [P. L.]. — On dead stems of Cerastium alpinum. (Asci 60×6—$7\ \mu$, 8-spored. Spores biseriate, 15—$16 \times 3\ \mu$.)

Stamnaria Fuckel.

343. **S. Equiseti** (Hoffmann) Saccardo, Syll. fung. VIII, p. 620.

Lycoperdon Equiseti Hoffmann. Vegetabilia Cryptogama II, p. 17.

Hof in Hörgardalur [O. D.], Akureyri [P. L.]. — On dead Equisetum palustre.

Coryne Tulasne.

344. **C. sarcoides** (Jacquin) Tulasne, Sel. fung. Carp. III, p. 190.

Hálsskógur [O. D.]. — On wood of Betula pubescens.

Geoglossaceae.

Mitrula Persoon.

345. **M. gracilis** Karsten, Revisio monogr. asc. Fenn., p. 110. — Saccardo, Syll. fung. VIII, p. 34.

Grundarfjörður [H. J.]. — On mosses.

Geoglossum Persoon.

246. **G. ophioglossoides** (Linné) Saccardo. Syll. fung. VIII, p. 43.

Geoglossum glabrum Persoon, Obs. Myc. II. p. 61.

Skriðudalur (Thoroddsen). — Growing among grasses and mosses.

Ascobolaceae.

Ascobolus Persoon.

347. **A. furfuraceus** Persoon, Obs. Myc. I, p. 33.

Peziza stercoraria Bulliard. Champ. France, p. 256.

Lurkasteinn [O. D.]. — On cow dung.

348. **A. glaber** Persoon, Obs. Myc. I, p. 34.

Blóndanes (Feddersen). — On cow dung.

349. **A. immersus** Persoon, Tentamen dispositionis methodicae Fungorum, p. 35.

Hof in Hörgárdalur [O. D.]. — On horse dung.

Lasiobolus Saccardo.

350. **L. equinus** (Müller) Karsten, Revisio monogr. asc. Fenn., p. 122.

Peziza equina Müller, Flora Danica, t. 779, fig. 3.

Hof in Hörgárdalur, Reistarárskarð, Hallgilsstaðafjall [O. D.], Reykjavík [P. L.]. — On horse- and sheep dung.

Ascophanus Boudier.

351. **A. subfuscus** Boudier, Mémoire sur les Ascobolés, Paris 1869, p. 52.

Rhaun in Fljótum [O. D.]. — On excrements of foxes.

352. **A. microsporus** (Berkeley et Broome) Hansen, Saccardo, Syll. fung. VIII, p. 532.

Ascobolus microsporus B. et Br., Notices of British Fungi, in Annals and Magazine of Natural History 1865, no. 1087, Pl. 16, fig. 28.

Reykjavík [P. L.]. — On horse dung.

Rhyparobius Boudier.

353. **R. crustaceus** (Fuckel) Rehm, Rabh. Krypt. Flora III, p. 1103.

Ascobolus crustaceus Fuckel, Hedwigia 1866, p. 4.

Lurkasteinn [O. D.]. — On cow dung.

354. **R. polysporus** Karsten, Myc. Fenn. I, p. 82.

Seyðisfjörður [P. L.]. — On sheep dung.

355. **R. dubius** Boudier, Mémoire sur le Ascobolés, p. 240, Pl. 10, Paris 1869, fig. 26.

Hofsfjall [O. D.]. — On sheep dung.

356. **R. hyalinellus** (Karsten) Saccardo, Syll. fung. VIII, p. 542.

Peziza hyalinella Karsten, Myc. Fenn. I, p. 83.

Hofsfjall [O. D.]. — On sheep and ptarmigan droppings.

357. **R. caninus** (Auerswald) Rehm, Rabh. Krypt. Flora III, p. 1102.

Ascobolus caninus Auerswald, Hedwigia 1868, p. 52.

Þorvaldsdalur [O. D.]. — On excrements of foxes.

Saccobolus Boudier.

358. **S. Kerveni** (Crouan) Boudier, l. c., p. 38, tab. 8, fig. 18.

Ascobolus Kerveni Crouan, Annales des scienc. nat. 1885, IV., vol. X, p. 193.

Seyðisfjörður [P. L.]. — On sheep dung.

Pezizaceae.

Lachnea Fries.

359. **L. scutellata** (Linné) Gillet, Discom. franç. Alençon 1889—1892, p. 75.

Peziza scutellata Linné, Flora Suecica, p. 458.

Möðruvallanes [O. D.], Glerá near Akureyri, Framnes near Dýrafjörður [C. H. O.], Egilsstaðir [P. L.], Bæjarstaðurskógur (Buchwald). — On damp soil.

360. **L. stercorea** (Persoon) Gillet, l. c., p. 76.

Peziza stercorea Persoon, Obs. Myc. II, p. 89.

Common throughout Iceland [O. D., St. St., H. J., P. L.]. — On horse- and cow-dung.

361. **L. hemisphaerica** Wiggers, Primitiae florae holsaticae, 1780, p. 107.

Egilsstaðir [P. L.]. — Among mosses under Betula pubescens.

Sphaerospora Saccardo.

362. **S. trechispora** (Berkeley et Broome) Saccardo, Consp. Discom., p. 4.

Peziza trechispora B. et Br., Notice of British Fungi, Annals and Magazine of Natural History XVIII 1846, p. 77.

Skagafjörður (Grønlund), Egilsstaðir [P. L.]. — On damp soil.

363. **S. confusa** (Cooke) Saccardo, Syll. fung. VIII, p. 190.

Möðruvellir [St. St.].

Plicariella Saccardo.

364. **P. modesta** (Karsten) Lindau.

Crouania modesta Karsten, Revisio monogr. asc. Fenn., p. 118.

Glerá near Akureyri [C. H. O.]. — On damp sandy soil.

365. **P. Empetri** (Rostrup).

Phaeopezia Empetri Rostrup, Isl. Svampe 1903, p. 317.

Hestahraun in Þorvaldsdalur [O. D.]. — On dead leaves of Empetrum nigrum.

Plicaria Fuckel.

366. **P. sepiatra** (Cooke) Rehm, Rabh. Krypt. Flora III, p. 119.

Peziza sepiatra Cooke, Grevillea III, p. 119.

Búðir [H. J.].

Humaria Fries.

367. **H. aquatica** (Lamarck et De Candolle) Rehm, Rabh. Krypt. Flora III, p. 954.

Möðruvellir [O. D.]. — On a piece of sacking lying in a swamp.

368. **H. granulata** (Bulliard) Quélet, Enchir. fung., Paris 1886, p. 290.

Peziza granulata Bulliard, Histoire des champignons de la France, p. 258.

Vallanes [H. J.]. — On manure.

369. **H. Jungermanniae** (Nees) Saccardo.

Peziza Jungermanniae Nees, in Fries Syst. Myc., vol. II, p. 144.
Mollisia J. (Nees) Rehm, Rabenhorst's Kryptogamenflora, III., p. 548.

Mulá (Feddersen). — On Hepaticae.

Geopyxis Persoon.

370. **G. cupularis** (Linné) Saccardo, Syll. fung. VIII, p. 72.

Peziza cupularis L., Species plantarum I, p. 1181.

Found in Iceland by König.

371. **G. Ciborium** (Vahl) Saccardo, Syll. fung, VIII, p. 64.

Peziza Ciborium Vahl, Flora Danica. Pl. 1078.

Dýrafjörður [C. H. O.]. — On damp soil in a bog.

Acetabula Fries.

372. **A. leucomelas** (Persoon) Boudier, Sacc., Syll. fung. VIII, p. 60.

Peziza leucomelas Persoon, Mycologia europaea, p. 219.

Laxá near Mývatn [P. L.]. — In a dense clump on damp sandy soil.

373. **A. sulcata** (Persoon) Fuckel, Symbolae, p. 330.

Peziza sulcata Persoon, Synops. meth. fung., p. 643.

Akureyri and Þingeyri [C. H. O.], Möðruvellir, Hállsskógur [O. D.]; Grund south of Akureyri [P. L.].

Macropodia Fuckel.

374. **M. Corium** (Weberbauer) Saccardo, Syll. fung. VIII, p. 159.

Peziza Corium Weberbauer, Pilze, t. III, fig. 7.

Hof in Hörgárdalur [O. D.]. — On sandy soil.

Helvellaceae.

Helvella Linné.

375. **H. atra** König, Zoëga, Flora Islandica 1772, p. 20.

Möðruvellir [St. St.].

Verpa Swartz.

376. **V. digitaliformis** Persoon, Myc. Eur., p. 202, t. 7, fig. 1—3.

Skútustaðir near the south end of Mývatn [P. L.]. — On a knoll in the lava field.

Coleosporiaceae.

Coleosporium Léveillé.

377. **C. Campanulae** (Persoon) Léveillé.

Uredo Campanulae Persoon, Synops. meth. fung., p. 217.

Hörgárdalur [O. D.]; Svarfaðardalur (J. Jóhannsson); Egilsstaðir in Vopnafjörður [St. St.]. — On Campanula rotundifolia.

Melampsoraceae.

Melampsorella Schroeter.

378. **M. Cerastii** (Persoon) Winter.

Uredo Cerastii Persoon, Synops. meth. fung., p. 219.

Þorvaldsdalur, Flatatúnga, Þrastarhólsgil [O. D.]; Hafnardalur [St. St.]; Hraun near Hekla, Hvítáfos (Feddersen); Dyrafjörður, Þingeyri, Hólmanes, Eskifjörður, Viðey near Reykjavík [C. H. O.]. — On Cerastium alpinum and C. vulgatum.

Melampsora Castagne.

379. **M. arctica** Rostrup, Grønl. Svampe 1888, p. 535.

Common throughout the country, recorded from about 40 different localities. — On Salix herbacea, S. glauca, S. phylicifolia and S. lanata.

380. **M. betulina** (Persoon) Tulasne.

Uredo betulina Persoon, Synops. meth. fung., p. 219.

Hallormstaðir (P. L. and Buchwald). — On seedlings of Betula pubescens in a nursery garden.

381. **M. Lini** (Persoon) Tulasne.

Uredo Lini Persoon, Synops. meth. fung., p. 216.

Fornhagagil, Hof [O. D.]; Glerá [C. H. O.]; Reykhús, Eyjafjörður (Strömfelt); Staðarfell [H. J.]. — On Linum cartharticum.

382. **M. Pyrolae** (Gmelin) Schroeter, Die Pilze Schlesiens 1. H., p. 366.

Böggverstaðadalur [O. D.]; Asbyrgi [St. St.]. — On Pyrola minor and P. secunda.

383. **M. Vacciniorum** (Link) Schroeter, l. c., p. 365.

Hofsfjall, Reistarárfossar, Hraun in Fljót, Þorvaldsdalur [O. D.]. — On Vaccinium uliginosum and V. Myrtillus.

384. **M. pustulata** (Persoon) Schroeter, l. c., p. 364.

Uredo pustulata Persoon, Synops. meth. fung., p. 219.

Skrifla (Grønlund); Uxahver [O. D.]; Reykhús, Eyjafjörður (Strömfelt); Sandey in Þingvallavatn (Feddersen). — On Epilobium palustre, E. alpinum.

385. **M. Saxifragarum** (De Candolle) Schroeter, l. c., p. 375.

Common throughout the country. — On Saxifraga caespitosa, S. hypnoides, S. aizoides, S. oppositifolia.

Hyalospora Magnus.

386. **H. Polypodii** (Persoon) Magnus.

Uredo Polypodii Persoon, Synops. meth. fung., p. 217.

Skútustaðir near Mývatn [O. D.]; Stórugjá; Hrófberg near Steingrímsfjörður [St. St.]; Rauðavatn (Feddersen). — On Cystopteris fragilis.

Cronartiaceae.

Chrysomyxa Unger.

387. **C. Pyrolae** (De Candolle) Rostrup, Mycologische Notiz. Bot. Centralbl. V, 1881, p. 126. — Sacc., Syll. fung. VII, II, p. 761.

Aecidium Pyrolae De Candolle, Flor. fr. VI, p. 99.

Skutulsfjörður [C. H. O.]. — On Pyrola minor.

Pucciniaceae.

Uromyces Link.

388. **U. Dactylidis** Otth; E. Rostrup, Plantepatologi, København 1902, p. 275.

Hörgárdalur, Hof [O. D.]. — On Poa alpina, P. pratensis and Deschampsia caespitosa.

389. **U. Festucae** Sydow, Hedwigia 1990, p. 117. Saccardo, Syll. fung. XVI, p. 269.

S. W. Icel. [H. J.]. — On Festuca rubra.

390. **U. Polygoni** (Persoon) Fuckel.

Puccinia Polygoni Persoon, Tentamen dispositionis methodicae fungorum, 1797.

Akureyri (Grønlund); Möðruvellir [O. D.]; Borgarnes, Reykjavík [H. J.]; Hvammsfjörður (Feddersen). — On Polygonum aviculare.

391. **U. Alchimillae** (Persoon) Léveillé.

Uredo Alchimillae Persoon, Synops. meth. fung., p. 215.

Common throughout the country. — On Alchimilla vulgaris.

392. **U. Trifolii** (Hedwig f.) Léveillé.

Puccinia Trifolii Hedwig f., Fungi ined. (La Marck et De Candolle, Fl. franç. II t. 18. With reference to Schroeter: Die Pilze Schlesiens I, p. 301).

Fornhagagil, Hof in Hörgárdalur [O. D.]. — On Trifolium repens.

393. **U. Limonii** (De Candolle) Léveillé. Sydow: Monographia Uredinearum, vol. II: Uromyces, p. 41.

Eskifjörður (Strömfelt). — On Armeria maritima.

Puccinia Persoon.

394. **P. Anthoxanthi** Fuckel. Sydow: Monographia Uredinearum, vol. I, p. 727.

Fornhagagil, Hof [O. D.]. — On Anthoxanthum odoratum.

395. **P. borealis** Juel, Hedwigia 1895, p. 16. — Sacc., Syll. fung., XI, p. 199.

Hörgárdalur, Möðruvallanes, Hraun in Fljót, Hof, Geirhildargarðar in Øxnadal [O. D.]; Hvarf [St. St.]. — On Agrostis sp., Calamagrostis stricta, Hierochloë odorata, Anthoxanthum odoratum, Deschampsia caespitosa.

396. **P. Poarum** Nielsen, Botan. Tidskr., 3. R., 2. Bd., 1877, p. 34.

Hof in Hörgárdalur, Möðrufellshraun [O. D.]. — On Poa pratensis, P. alpina.

397. **P. Caricis** (Schumacher) Rebentisch.

Uredo Caricis Schum., Nr. 1555, Flora Danica, tab. 317, fig. 2.

Hraunsvatn, Akranes [O. D.]; Reykjavík (Berlin). — On Carex atrata, C. Goodenoughii and C. sp.

398. **P. uliginosa** Juel, Sydow, Monogr. Ured., vol. I, p. 673.

Lambardalur in Dýrafjörður [C. H. O.], S. W. Iceland [H. J.]. — On Carex sp., Parnassia palustris (Aecidium).

399. **P. septentrionalis** Juel. Öfversigt af Kongl. Vetenskaps-Akademiens Förhandlingar 52 (1895), p. 383.

Very common throughout the country. — On Polygonum viviparum and aecidial stage on Thalictrum alpinum (Aecidium Sommerfeltii).

400. **P. Bistortae** (Straus) De Candolle. Sydow, Monogr. Ured., vol. I, p. 571.

S. W. Iceland [H. J.]; Grímsey, Hof [O. D.]; Skjoldolfsstaðir, Gufudalsháls [St. St.]. — On Polygonum viviparum.

401. **P. Oxyriae** Fuckel, Sydow: Monogr. Ured., vol. I, p. 567.

Gaunguskarð [O. D.]. — On Oxyria digyna.

402. **P. Blyttiana** Lagerheim. Saccardo, Syll. fung. XI, p. 174.

Reislarárskarð [O. D.]. — On Ranunculus acer.

403. **P. Cruciferarum** Rudolphi, in Linnæa IV, p. 391. — Saccardo, Syll. fung. VII, II, p. 724.

Hof in Hörgárdalur [O. D.]. — On Cardamine pratensis.

404. **P. Drabae** Rudolphi, Sydow, Monogr. Ured., vol. I, p. 512.

Oddeyri [C. H. O.]; Fornhagagil, Arnarnes, Gásaeyri, Hörgárdalur [O. D.]; Arnarfell, Reykir in Reykjabraut [St. St.]; Hrappsey in Breiðifjörður [Gudm. Magnússon]; Melstaður, Þingvellir [Feddersen]; Mývatn, Skrifla [Grønlund]. — On Draba incana, D. hirta.

405. **P. Saxifragae** Schlechtendal, Sydow, Monogr. Ured., vol. I, p. 500.

Hofsfjall, Skútustaðir near Mývatn [O. D.]; Veðramótsteigur [Jón Björnsson]; Eskifjörður [Strömfelt]. — On Saxifraga nivalis, S. stellaris.

406. **P. Fergussonii** Berkeley et Broome, Sydow, Monogr. Ured., vol. I, p. 444.

Fornhagagil, Hof, Hvammur on Galmarströnd [O. D.]; Skælingar [Thoroddsen]. — On Viola palustris.

407. **P. Morthieri** Körnicke, Sydow, Hedwigia 1877, p. 19. — Saccardo, Syll. fung. VII, II, p. 681.

Reykjahlíð near Mývatn [P. L.]. — On leaves of Geranium silvaticum.

408. **P. Violae** (Schumacher) De Candolle, Sydow, Monogr. Ured., vol. I, p. 439.

Uredo Violae Schumacher Nr. 1570, Flora Danica, tab. 1317.

Grafarbakki [O. D.]; Reykjavík, Krisuvík [C. H. O.]. — On Viola silvatica, V. canina.

409. **P. Epilobii** De Candolle, Sydow, Monogr. Ured., vol. I, p. 427.

Hörgárdalur, Möðruvellir, Reistarárskarð, Hraun in Fljót [O. D.]; Fljótsheiði [Grønlund]; Guðfinnugjá near Yxnihola [Björn Guðmundsson]; Geldingsá [St. St.]; Gaunguskarð, Hofskarð, Laufás [Feddersen]; Dýrafjörður, Látravík, Adalvík [C. H. O.]; Fróðárheiði [H. J.]. — On Epilobium palustre, E. alpinum, E. lactiflorum, E. alsinefolium.

410. **P. Halosciadis** Sydow, Annales Mycologici 17 (1919), p. 33.

Axarey in Breiðifjörður [H. J.]. — On Haloscias scoticum.

411. **P. Schneideri** Schroeter, Die Pilze Schlesiens I, p. 344.

Hjeðinshöfði, Þorvaldsdalur [O. D.]; Oddeyri, Dýrafjörður, Eskifjörður [C. H. O.]. — On Thymus serpyllum.

412. **P. Veronicarum** De Candolle, Sydow, Monogr. Ured., vol. I, p. 257.

Möðruvellir [St. St.]; Hofsfjall, Hestahraun in Þorvaldsdalur [O. D.]. — On Veronica alpina.

413. **P. punctata** Link, Sydow, Monogr. Ured., vol. I, p. 213.

Puccinia Galii (Persoon) Schw.

Möðruvellir [St. St.]; Eskifjörður [Strömfelt]; Seyðisfjörður [P. L.]. — On Galium silvestre.

414. **P. Leontodontis** Jacky, Sydow, Monogr. Ured., vol. I, p. 114.

Möðruvellir [G. Gudmundsson]; Hof, Hjeðinshöfði [O. D.]. — On Leontodon autumnalis.

415. **P. variabilis** Greville, Sydow, Monogr. Ured., vol. I, p. 163.

Common throughout the country. — Om Taraxacum sp.

416. **P. silvatica** Schroeter, Die Pilze Schlesiens I, p. 328.

Grund (S. W. Iceland) [H. J.]. — On Taraxacum croceum.

417. **P. Hieracii** Martius, Sydow, Monogr. Ured., vol. I, p. 95.

Kolká, Eskifjörður [Strömfelt]; Hörgárdalur, Mývatn, Þorvaldsdalur [O. D.]; Melrakkasljetta, Dýrafjörður [C. H. O.]. — On Hieracium murorum, H. alpinum, H. islandicum.

Triphragmium Link.

418. **T. Ulmariae** (Schumacher) Link.

Uredo Ulmariae Schumacher, Enum. plant. Selland. No. 1533.

Prestsbakkaheiði [St. St.]; Birtingahalt [H. J.]. — On Filipendula Ulmaria.

Of *Uredo* forms whose teleutospores are not yet known, the following occurs in Iceland:

419. **Uredo Airae** Lagerheim, Journal de Botanique II, 1888, p. 432.

Reykjavík [H. J.]. — On Deschampsia caespitosa.

Ustilaginaceae.

Ustilago Persoon.

420. **U. Hordei** (Persoon) Kellermann et Swingle.

Uredo Hordei Persoon, Synops. meth. fung., p. 224.
Ustilago Jensenii Rostrup, Ustilagineae Daniae, 1890, p. 138.

Akureyri, Möðruvellir [St. St.]. — On Hordeum vulgare.

421. **U. Bistortarum** (De Candolle) Körnicke, Hedwigia 1877, p. 88. — Saccardo, Syll. fung. VII, II, p. 469.

Hörgárdalur [O. D.]; Stykkishólmur [H. J.]; Dýrafjörður, Þingeyri [C. H. O.]. — On leaves of Polygonum viviparum.

422. **U. vinosa** (Berkeley) Tulasne, Saccardo, Syll. fung., VII, p. 469.

Hestahraun in Þorvaldsdalur, Hraun in Fljót [O. D.]. Þórsmörk in S. W. Iceland [H. J.]. — In flowers of Oxyria digyna.

423. **U. violacea** (Persoon) Roussel, Saccardo, Syll. fung., VII, p. 474.

Djúpárbakki [St. St.]; common at Eskifjörður, Ísafjörður, Dýrafjörður, Reykjavík [C. H. O.]. — On Silene acaulis.

Sphacelotheca De Bary.

424. **S. Hydropiperis** (Schumacher) De Bary.

Uredo Hydropiperis Schumacher, Enum. plant. Sell., No. 1580.

Grímsey [Thoroddsen]; Sauðanes [St. St.]; Hof [O. D.]; Látravík, Aðalvík, Eskifjörður [C. H. O.]; Staðarhraun, Þingvellir [Feddersen]; Berufjörður [Grønlund]; Stjúpmóðurhólmi, Búðir, Grund [S. W. Iceland] [H. J.]. Of wide distribution in many localities [H. J.]. — In the inflorescences of Polygonum viviparum.

Cintractia Cornu.

425. **C. Caricis** (Persoon) Magnus.

Uredo Caricis Persoon, Synops. meth. fung., p. 225.

Common throughout Iceland. — On Carex dioeca, C. stellulata, C. rigida, C. Goodenoughii, C. capellaris, C. panicea, Kobresia Bellardii, Scirpus caespitosus.

426. **C. Luzulae** (Saccardo) Clinton.

Ustilago Luzulae Saccardo, Syll. fung., VII, p. 463

Búðartungugil, Hraun in Fljót [O. D.]. — On Luzula multiflora.

Tolyposporium Woronin.

427. **T. Junci** (Schroeter) Woronin, Saccardo, Syll. fung., VII, p. 501.

Glerá near Akureyri [C. H. O.]; Möðruvellir [O. D.]. — Filling up the whole stem of Juncus balticus.

428. **T. Montiae** Rostrup, Vejledn. i d. danske Flora, II. Del, 1904, p. 31.

Sorosporium Montiae Rostrup, Mykologiske Meddelelser VI. Botanisk Tidsskrift, vol. 20, 1896, p. 128.

Dýrafjörður, Þingeyri [C. H. O.]. — On Montia rivularis.

Tilletiaceae.

Tilletia Tulasne.

429. **T. striiformis** (Westendorp) Winter, Saccardo, Syll. fung., vol. VII, p. 485.

Möðruvellir [St. St.]. — On Calamagrostis stricta and Poa pratensis.

430. **T. arctica** Rostrup, Svampe fra Finmarken, Botanisk Tidsskrift, XV, 1886, p. 230. Saccardo, Syll. fung. VII, II, p. 486.

Cintractia arctica (Rostrup) Lagerheim.

Möðruvellir [O. D.]. — On leaves of Carex sp.

Entyloma De Bary.

431. **E. crastophilum** Saccardo, Syll. fung., vol. VII, p. 491.

Geirhildargarður in Öxnadal [O. D.]. — On leaves of Deschampsia caespitosa.

432. **E. Catabrosae** Johanson, Svampar från Isl. 1884, p. 160.

Hólar [Strömfelt]; Kollafjarðarnes [G. Gudmundsson]. — On leaves of Catabrosa aquatica.

433. **E. irregulare** Johanson, Svampar från Isl. 1884, p. 159.

Eyjafjörður, Reykhús [Strömfelt]; Litla Arskógssandur, Grafarbakki [O. D.]. — On leaves of Poa annua.

434. **E. Ranunculi** (Bonorden) Schroeter, Saccardo, Syll. fung., vol. VII, p. 488.

Hof, Möðruvellir [O. D.]. — On Ranunculus acer.

435. **E. Calendulae** (Oudemans) De Bary, Saccardo, Syll. fung., vol. VII, p. 492.

Gufudalsháls [St. St.]. — On Hieracium murorum.

Urocystis Rabenhorst.

436. **U. Fischeri** Körnicke, Saccardo, Syll. fung., vol. VII, p. 516.

Urocystis Agropyri Schroeter.

Lónsleirur [O. D.]. — On leaves of Carex salina.

437. **U. sorosporioides** Körnicke, Saccardo, Syll. fung., vol. VII, p. 519.

Hof in Hörgárdalur [O. D.]. — On Thalictrum alpinum.

Tremellaceae.

Exidia Fries.

438. **E. repanda** Fries, Syst. Myc. II, p. 225.

Þórðarstaðaskógur, Husafellsskógur [O. D.]; Hallormstaðir, Lómagnupur, Bæjarstaður [Buchwald]. — On Betula pubescens.

439. **E. albida** (Hudson) Brefeld, Saccardo, Syll. fung. VI, p. 775.

Þingvellir, Vífilsstaðahlíð [P. L.]. — On dead branches of Betula pubescens.

Tremella Dillenius.

440. **T. lutescens** Persoon, Synops. meth. fung., p. 622.

Hálsskógur, Húsafellsskógur [O. D.]. — On bark of Betula pubescens.

Dacryomycetaceae.

Dacryomyces Nees.

441. **D. deliquescens** (Bulliard) Duby.

Tremella deliquescens Bulliard, t. 455, Fig. 3.

Hálsskógur, Húsafellsskógur [O. D.]; a garden in Reykjavík [Buchwald]. — On wood of Betula pubescens.

442. **D. stillatus** Nees, Ueberblick des Systems der Pilze und Schwämme, 1847, p. 89, Fig. 90.

Gásir [O. D.]. — On wood washed up by the sea.

Exobasidiaceae.

Exobasidium Woronin.

443. **E. Vaccinii** (Fuckel) Woronin, Saccardo, Syll. fung. VI, p. 664.

Fusidium Vaccinii Fuckel, Mycologisches, Bot. Zeit., 1861, vol. 19, p. 251.

Vallneskinn, Víkúrfjall [St. St.]; Hvarf, Melrakkasljetta near Grjótnes [C. H. O.]; Hörgárdalur, Hestahraun, Hraun in Fljót [O. D.]; Kolbeinsá, Haukadalsá [H. J.]. — On Vaccinium Myrtillus, V. uliginosum.

444. **E. Warmingii** Rostrup, Grønl. Svampe 1888, p. 530. — Saccardo, Syll. fung. VI, p. 245.

Bær [St. St.]; Hólmanes [C. H. O.]. — On Saxifraga oppositifolia.

Clavariaceae ex parte.

Clavaria Vaillant (but only the stichobasidial species).

445. **C. cinerea** Bulliard, t. 354. — Fries, Syst. Myc., vol. I, p. 468.

Hofsfjall, Gúfunes [O. D.]; Eyjólfstaðir Skógur [P. L.]. — In birch copses.

446. **C. cristata** Persoon, Synops. meth. fung., p. 591.

Hof in Hörgárdalur, Hraun in Fljót [O. D.].

Cantharellaceae.

Leptotus Karsten.

447. **L. lobatus** (Persoon) Karsten.

Merulius lobatus Persoon, Myc. Eur., II, p. 23.

Hofsfjall [O. D.]; Eskifjörður [C. H. O.]; Hallormstaðir, Mývatn [P. L.]. — On mosses.

Leptoglossum Karsten.

448. **L. glaucum** (Batsch) Ricken, Die Blätterpilze, Leipzig 1915, p. 5.

Hallormstaðir [P. L.]. — On peaty soil.

449. **L. muscigenum** (Bulliard) Ricken, l. c., p. 5.

Hallormstaðir [P. L.]. — On the edges of ditches among mosses.

Thelephoraceae.

Thelephora Ehrhart.

450. **T. caryophyllea** (Schaeffer) Persoon.

Helvella caryophyllea Schaeffer, Fungorum .... icones, t. 325.

Found in Iceland by König (Flora Danica, t. 409, f. 2).

451. **T. terrestris** Ehrhart, Beiträge kryptogam. Botanik, Nr. 179.

Þrastarhólsskarð [O. D.]; Hallormstaðir [P. L.]. — On tufts of Luzula and on the ground under birches.

Hydnaceae.

Hydnum Linné.

452. **H. argutum** Fries, Syst. Myc. I, p. 424.

Húsafellsskógur [O. D.]. — On dead leaves of Betula pubescens.

Corticiaceae.

Tomentella Persoon.

453. **T. ferruginea** Persoon, Obs. Myc., vol. 2, p. 18.

Hálsskógur [O. D.]. — On Betula pubescens.

Corticium Persoon.

454. **C. radiosum** Fries, Epicrisis systematis mycologici, p. 560.

Möðruvellir [St. St.]. — On wood.

455. **C. salicinum** Fries, Epicr., p. 558.

Bæjarstaður [H. J.]. — On branches of willow.

456. **C. granulatum** (Bonorden) Winter, Rabenhorst's Kryptogamen-flora I, 1., p. 329.

Hypochnus granulatus Bonorden, Handbuch der allg. Myk., p. 169.

Hálsskógur [O. D.]. — On Betula pubescens.

457. **C. incarnatum** Fries, Epicr., p. 564.

Bildsfell, Þingvellir [Feddersen]; Bæjarstaður [Buchwald]. — On Betula pubescens and Sorbus aucuparia.

Coniophora De Candolle.

458. **C. puteana** (Schumacher) Fries, Hym. Eur., p. 657.

Thelephora puteana Schum., No. 1989, Flora Danica, tab. 2033, fig. I.

Grimsey [O. D.].

Stereum Persoon.

459. **S. vorticosum** Fries, Obs. Myc., vol. 2, p. 275.

Hálsskógur [O. D.]. — On Betula pubescens.

460. **S. hirsutum** (Willdenow) Persoon.

Thelephora hirsuta Willdenow, Florae berolinensis prodromus, 1787, p. 397.

Möðruvellir, Hálsskógur, Húsafellsskógur [O. D.]. — On Betula pubescens.

461. **S. rugosum** Persoon, Myc. Eur., vol. I, No. 30—34.

Norðtúnga [P. L.]; Hallormstaðir [Buchwald]. — On Betula pubescens.

462. **S. tuberculosum** Fries, Hym. Eur., p. 644.

Hálsskógur [O. D.]. — On Betula pubescens.

Cyphellaceae.

Cyphella Fries.

463. **C. villosa** (Persoon) Karsten, Mycologia fennica III, p. 325.

Fornhagagil [O. D.]. — On dead stems of Geranium silvaticum.

Clavariaceae ex parte.

In this section will be found the supposed chiastobasidiale forms of *Clavariaceae* Fries.

Typhula Fries.

464. **T. graminum** Karsten, Saccardo, Syll. fung. VI, p. 746.

Holm in Mývatn [Grønlund]; Hof in Hörgárdalur [O. D.]; Möðruvellir [St. St.]. — Sclerotia have been found on: Agrostis sp., Agropyrum violaceum and Carex rigida.

Clavaria Vaillant (ex parte).

465. **C. fragilis** Holmskiold, Beata ruris otia fungis danicis impensa, vol. I, p. 7.

Hjeðinshöfði [O. D.]; Egilsstaðir-Skógur [P. L.]. — In the latter locality among grass in a glade.

466. **C. inaequalis** Müller, Flora Danica, t. 837.

Hof in Hörgárdalur [O. D.].

467. **C. fastigiata** Fries, Syst. Myc. I, p. 467.

Clavaria muscoides Linné.

Möðruvellir [St. St.]; Hof in Hörgárdalur, Hraun in Fljót [O. D.]; Kirkjubæjarklaustur [Buchwald]; Effersey near Reykjavík [Svend Andersen].

Radulaceae.

Radulum Fries.

468. **R. orbiculare** Fries, Elenchus fungorum, I, p. 149.

Hálsskógur [O. D.]; Þingvellir [P. L.]. — On dead branches and trunks of Betula pubescens.

Phlebia Fries.

469. **P. radiata** Fries, Syst. Myc. I, p. 427.

Vídidalur [Grønlund]; Bæjarstaður [Buchwald]. — On wood and bark of Betula pubescens.

Meruliaceae.

Merulius Haller.

470. **M. lacrymans** Fries, Syst. Myc. I, p. 328.

Möðruvellir [St. St.]. — On floors and wainscot.

471. **M. corium** Fries, Elenchus fungorum I, p. 58.

Bæjarstaður [Buchwald]. — On dead branches of Betula pubescens.

Polyporaceae.

Poria Persoon.

472. **P. vaporarius** Fries, Saccardo, Syll. fung. VI, p. 311, and XVII, p. 131.

Möðruvellir [St. St.]. — In houses.

473. **P. medulla panis** Fries, Saccardo, Syll. fung. VI, p. 295.

Mödruvellir [St. St.]. — On beams in a cellar.

Polyporus Micheli.

474. **P. croceus** (Persoon) Fries, Syst. Myc. I, p. 364.

Hálsskógur [O. D.]. — On Betula pubescens.

475. **P. brumalis** (Persoon) Fries.

Boletus brumalis Persoon, Synops. meth. fung., p. 517.

Hálsskógur [St. St.]; Voglaskógur [O. D.]; Hallormstaðir [P. L.]. — On stumps and fallen branches of birch.

Polystictus Fries.

476. **P. hirsutus** (Wulfen) Fries.

Polyporus hirsutus Fries, Syst. Myc. I, p. 367.

Egilsstaðir [P. L.]. — On fallen branches of Betula pubescens.

477. **P. perennis** (Linné) Fries.

Boletus perennis Linné, Flora Suecica, No. 1245.

Lomagnupur (Buchwald). — On the ground in an Empetrum-Calluna-heath.

Hygrophoraceae.

Hygrophorus Fries.

478. **Hygrophorus conicus** (Scopoli) Fries, Hym. Eur., p. 419.

Mývatn (Grønlund); Akureyri, Reykjavík [C. H. O.]; Hallormstaðir and Skútustaðir [P. L.]. — On knolls in outfields and in homefields.

Cap conical, margin straight, colour 1 6 and 1 7, becoming black. Flesh thin, yellow, becoming black. Stipe cylindrical, yellow, white below, becoming black. Gills broadest anteriorly, nearly free, at first almost white, then yellow, becoming black. Spores white, elongate-ovate, $9-11 \times 5-6\ \mu$.

479. **H. miniatus** Fries, Hym. Eur., p. 418.

Egilsstaðir (Lagarfljót) [P. L.]. — Among grass in outfields.

Cap 1—2 cm broad, convex, orange-red, covered with fine yellow scales (projecting hyphæ with yellow contents). Stipe cylindrical, stuffed, coloured like the cap, above clad with yellow scales. Gills thick, rather distant, broadly adnate, decurrent tooth, yellow to orange. Spores white, nearly cylindrical, $8-9 \times 5-5.5\ \mu$.

480. **H. pratensis** (Persoon) Fries, Hym. Eur., p. 413.

Hof in Hörgárdalur [O. D.]; Seyðisfjörður [P. L.].

Cap 3—5 cm broad, flat, gibbose, margin thin, orange-yellow (1 6). Stipe concolorous but paler, cylindrical, thinner below. Gills thick, distant, concolorous, strongly decurrent. Spores white, ellipsoidal, $6 \times 4\ \mu$.

481. **H. niveus** (Scopoli) Fries, Hym. Eur., p. 414.

Seyðisfjörður [P. L.]. — Among grass in a homefield.

Cap plano-convex, umbilicately depresssed, white, hygrophanous, when moist pellucidly striate at margin. Stipe hollow, white, dilated above. Gills thin, white, distant, arcuate-decurrent. Spores white, subcylindrical, 8×4—5 μ.

Agaricaceae.

Clitocybe Fries.

482. **C. gilva** (Persoon) Fries, Hym. Eur., p. 95.

Agaricus gilvus Persoon, Synops. meth. fung., p. 448.

Seyðisfjörður [P. L.]; Dýrafjörður [C. H. O.]. — In grass on mountain slopes among Betula nana and Salix herbacea.

Cap 5—8 cm broad, plano-convex, depressed at centre, in damp weather yellowish brown (g 2), in the dry state greyish yellow (k 4), margin involute, mealy and sulcate. Flesh pale yellow (k 1 to k 2), stipe cylindrical, stuffed, at length hollow, 8 cm high, 8—15 mm thick, pale yellow (k 2), even and naked, but enveloped in white hairs at base. Gills narrow, crowded, decurrent, furcate below, creamcoloured (k 1). Spores white, ovoid, 5×3—4 μ.

483. **C. odora** (Bulliard) Fries, Hym. Eur., p. 85.

Agaricus odorus Bulliard, 1791, t. 556, fig. 3.

Eyjolfstaðir (near Grimsá) [P. L.]. — Under birches.

Cap 4—6 cm broad, plano-convex, fleshy and firm, naked, greyish green (b 1 to b 3). Flesh pallid, smells strongly of anis. Stipe pale greyish green (e 1), somewhat inflated and hollow, at base with strongly decurrent and interwoven hyphæ. Gills white or the same colour as the stipe, broad, distant, only decurrent by a tooth. Spores white ellipsoidal, 6×4 μ.

484. **C. tornata** Fries.

Agaricus tornatus Fries, Hym. Eur., p. 87.

Hallormstaðir [P. L.]. — In a birch copse.

Cap 3—6 cm broad, convex, occasionally somewhat gibbous, not hygrophanous, white and covered with a white mealy layer, in age with deep cracks in the flesh of cap, becoming alutaceous. Stipe short, of unequal thickness, dilated now at apex, now at base, stuffed, white. Gills narrow, crowded, white, adnate, only decurrent by a tooth. Spores white, small, 4—5×2 μ.

485. **C. dealbata** (Sowerby) Fries, Syst. Myc. I, p. 92.

Agaricus dealbatus Sowerby, Coloured Fig. of English Fungi, London 1797—1805, t. 123.

Seyðisfjörður [P. L.]. — In a homefield.

Cap 3—5 cm broad, elongated, frequently with somewhat irregular sinuous margin, flesh thin, white to watergrey, silky when dry. Stipe cylindrical, stuffed, 3—4 cm high and 3—5 mm thick, white or greyish, felted at top. Gills crowded, white, broadly adnate, only slightly decurrent. The flesh smells and tastes of flour. Spores smooth, white, ellipsoidal, 5×3 μ.

Omphalia (Persoon) Fries.

486. **O. hepatica** (Batsch) Fries, Hym. Eur., p. 160.

Agaricus hepaticus Batsch, Elenchus fungorum, f. 211.

Akureyri [P. L.]. — On grass-covered, sandy meadows at Glerá.

Cap 1.5—2.5 cm broad with incurved margin, plano-convex, even, without or with a very slight depression in the centre, hygrophanous, reddish brown (i 4), in the old fungus the cap becomes crateriform with a pendent, undulate and somewhat sulcate margin, and turns alutaceous in colour (j 1), first in the centre and then at the margin. Stipe cylindrical, hollow, 1.5—3 cm high, 2 mm thick, pale reddish brown (j 2), naked, the base covered with white hyphæ. Gills distant, rather narrow, at length strongly decurrent, coloured like the stem. Spores ovoid, smooth, white, 7×4—5 μ. Basidia clubshaped with 4 up to 10 μ long sterigmata.

487. **O. onisca** Fries.

Agaricus oniscus Fries, Hym. Eur., p. 158.

Isafjörður, Þingvellir and Laugarnes near Reykjavík [P. L.]. — On peaty and swampy ground among mosses and sedges.

Cap c. 2 cm broad, deeply umbilicate, campanulate, pendulous, margin sulcate-undulate, at length lobate, hygrophanous dark brown (f 4), horn grey when dry. Stipe short, base somewhat tapering, stuffed, at length hollow, greyish brown, mealy, felted at base. Gills grey, rather crowded, decurrent. Spores piriform with oblique apex, smooth, white, 7.8×5 μ.

488. **O. umbellifera** (Linné) Fries, Hym. Eur., p. 160.

Agaricus umbelliferus Linné, Flora Suecica, No. 1192.

Akureyri [P. L.]; Hof in Hörgárdalur [O. D.]. — Occurs in great abundance among sedges, mosses, and Salix herbacea in the littoral field near Glerá.

Cap 5—10 mm broad, margin incurved and sulcate, centre umbilicate, straw-yellow (k 4). Stipe cylindrical with slightly dilated base, 2 cm high, 1—2 mm thick, stuffed, white, somewhat mealy, base felted. Gills distant, decurrent, rather broad, white. Spores ellipsoidal, white, smooth, 6.5—8×3.5 μ.

Pleurotus Fries.

489. **P. applicatus** (Batsch) Fries.

Agaricus applicatus Batsch, Elench. fung., Cont. I, p. 171, f. 125.

Hrafnagjá near Þingvallavatn [P. L.]. — On rotten branches of Betula pubescens.

Cap 4—5 mm broad, resupinate, crateriform pellicle gelatinous, greyish brown and mealy. There is no stipe, the fungus being attached by an excentric area of the surface of the cap. Gills distant, white or greyish white, anastomosing in an excentrically placed point. Spores white, smooth, broadly ellipsoidal, 5—6×4 μ.

Russuliopsis Schroeter.

490. **R. laccata** (Scopoli) Schroeter, var. **rosella** (Batsch) f. **pusilla.**

Agaricus laccatus Scopoli; Flora carniolica, p. 444.

Lagarfljót, Laxárdalur, Ljósavatnsskarð, littoral field near Akureyri, Isafjörður, meadows near Þverá (Norðtúnga), Laugarnes near Reykjavík [P. L.].

Cap 1—2 cm broad, flesh thin, smooth, palely or darkly incarnate (n 6 to n 7), margin skin-like, undulate-sulcate, centre somewhat depressed. Stipe short and thin, concolorous. Gills distant, rather thick, adnato-decurrent, coloured like the cap. Spores white, verrucose, spherical, 8—9 μ in diameter.

Entoloma Fries.

491. **E. sericeum** (Bulliard) Fries, Hym. Eur., p. 196.

Agaricus sericeus Bulliard, t. 413, f. 2.

Hallormstaðir [P. L.]. — On grass-covered spots in and around the birch copses.

Cap 3—5 cm broad, campanulate with broadly incurved margin and often with irregular depressions in various parts of the surface, hygrophanous, pellucidly striate, dark brown in various shades ranging about c 3, grey when dry, with a silky lustre. The flesh has the flavour and smell of flour. Stipe 3—5 cm high, 4—7 mm thick, cylindrical, stuffed, flesh stringy, often twisted. Gills grey, then red, sometimes broadly adnate, sometimes deeply emarginate, edge of gills often undulate. Spores incarnate, almost regularly pentagonal, now and then with an elongated apiculus, 8—9×7—8 μ, a few spores somewhat larger.

492. **E. rhodopolium** Fries.

Agaricus rhodopolius Fries, Syst. Myc. I, p. 197.

Birch copse near Eyjólfstaðir.

Cap 3—5 cm broad, campanulate, margin thin and incurved, hygrophanous, greyish brown when moist (h 6), white when dry. Stipe 7—9 cm high, 4—6 mm thick, cylindrical, hollow, somewhat cartilaginous, white. Gills rather crowded, broad, adnate, emarginate, with a decurrent tooth, at first white, then roseate. Spores incarnate, almost regularly pentagonal, 7—9 μ in diameter.

Leptonia Fries.

493. **L. lampropus** Fries.

Agaricus lampropus Fries, Syst. Myc. I, p. 203.

Vallanes near Lagarfljót [P. L.]. — On sandy grass-covered spots.

Cap 2—3 cm broad, convex or plano-convex, not hygrophanous, margin involute, brown with a bluish tinge (f 3). Stipe cartilaginous, hollow, glabrous, bluish violet (a 2, but more blue). Gills at first greyish white, then greyish red, broad, but loosely attached to the stipe. Spores angular, incarnate, 10—12×8—9 μ.

494. **L. serrulata** (Persoon) Fries, Hym. Eur., p. 203.

Agaricus serrulatus Persoon, Synops. meth. fung. I, p. 463.

Egilsstaðir [P. L.]. — In grass-covered, knolly outfields.

Cap from barely 1 to 4 cm broad, plano-convex, with incurved and involute margin, later expanded, throughout the development with umbilicate centre, surface shortly adpressed-pubescent, shining, from a deep black-violet (somewhat darker than a 1) to brown-violet (o 2); the flesh below the cuticle is a pale bluish red. Stipe cylindrical, as much as 4 cm high, 2—3 mm thick, blackish blue at top, paler below, base covered with white hairs. Gills emarginate, pale violet at first (o 4), later incarnate, edge of gills coarsely dentate and black. Spores oblong, obtusely pentagonal, elongated to an oblique apiculus, incarnate, 10—11×7—8 μ. No cystidia, the blackish blue colour of the edge of the gills being due to the coloured contents of the hyphæ.

495. **L. sericella** (Fries) Quélet.

Agaricus sericellus Fries, Syst. Myc. I, p. 196.

Vallanes, Egilsstaðir [P. L.]. — On knolls in outfields and at roadsides.

Cap 1—4 cm broad, at first convex, with incurved margin, white with a yellowish centre, with a silky, mealy-fibrous coating, then somewhat orange-coloured (l 6), finely squamulose and depressed at centre. Stipe cylindrical, up to 3 mm thick, pellucid, hollow, white at first, then yellowish. Gills distant, adnate and slightly decurrent, white, then pink to incarnate. Spores incarnate, angular, almost isodiametrical, 8—10 ×7—8 μ.

Nolanea Fries.

496. **N. juncea** Fries.

Agaricus junceus Fries, Syst. Myc. I, p. 208.

Brekka near Lagarfljót and at Hallormstaðir [P. L.]. — In wet bogs among mosses.

Cap 1.5—2.5 cm broad, flatly conical, with obtuse or depressed disc, hygrophanous, pellucidly striate, surface rough, minutely pitted and slightly squamulose, dark brown when moist (f 3), grey when dry (i 3).

Stipe cylindrical, 6—7 cm long, 2 mm thick, cartilaginous, brown, but covered with greyish white fibres; gills broad, distant, rather thick and rigid, strongly rounded towards the stem, almost free, grey, then incarnate. Spores very variable in shape, sometimes polygonal, sometimes oblong and irregularly angular, drawn out below into an oblique apiculus, 9—11×8 μ.

Mycena Fries.

497. **M. avenacea** Fries, sensu Schroeter, Die Pilze Schlesiens I, p. 638.

Agaricus avenaceus Fries, Systema mycologicum I, p. 150.

Seyðisfjörður [P. L.]. — On and among grassy knolls in outfields.

Cap 1—1,5 cm broad, conic-campanulate, margin pellucido-striate, greyish brown (g 6), darker at centre. Stipe 4—5 cm long, 1—2 mm thick, hollow, tough, shining, pale, finally greyish yellow (k 2). Gills distant, white, brown-rimmed. Spores ellipsoidal, smooth, white, 12×5—6 μ. Edge of gills closely beset with flaskshaped cystidia with brown contents.

Marasmius Fries.

498. **M. Vaillantii** (Persoon) Fries, Epicr. p. 380.

Dýrafjörður, Þingeyri [C. H. O.] det. E. Rostrup.

499. **M. insititius** Fries, Epicr. p. 386.

Hof in Hörgárdalur [O. D.] det. E. Rostrup.

Tricholoma Fries.

500. **T. gambosum** Fries.

Agaricus gambosus Fries, Syst. Myc. I, p. 50.

Fnjóskadalskógur [C. H. O.].

501. **T. pubifolium** Romell, Hymenomycetes of Lappland, pp. 2 and 3.

Hallormstaðir, Möðrudalur, Reykjahlíð and Skútustaðir [P. L.].

Cap 4—7 cm broad, campanulate, obtusely gibbous margin involute, centre palely ochraceous (k 2), the rest white, the whole surface (under the lens) minutely and densely pubescent, which gives the cap a dull appearance. Flesh thick and white, with no special scent or flavour. Stipe 6—7 cm long, 1—2 cm thick, cylindrical with somewhat swollen base, stuffed, white, assumes a brownish tinge when touched, densely mealy at apex, the rest smooth. Gills narrow, crowded, emarginate, white with transverse stripes. Spores ellipsoidal, white or a faint brown, 1-guttulate 9—11×5—6 μ.

T. pubifolium deviates from *T. gambosum*, which it resembles most, by the absence of the mealy odour and flavour and by the much larger spores.

502. **T. panaeolum** Fries, Epicr., p. 49.

Hjarðarholt and Laugarnes [P. L.]. — On grassy spots in heaths and bogs.

Cap 5—10 cm broad, at first plano-convex, with margin inrolled, predominating colour clay-brown with a reddish brown tinge (h 2), shot with grey stripes, then concave, paler brown (h 3), here and there with round, dark brown spots of moisture, sometimes arranged in a zone inside the margin of the cap. Stipe 4—6 cm long, 1—2 cm thick, spongy inside, firm outside, greyish brown (h 4), here and there covered with greyish white adpressed hairs. Flesh pale with mealy odour and flavour. Gills fairly crowded, emarginate, often with transverse veins and anastomosing. The colour is b 8 to b 7, at length with edge of gills brown. Spores shortly ellipsoidal, 5—6×4 μ, pale. The spore powder is pale brown.

Grows in dense clusters arranged in circles.

503. **T. aggregatum** Quélet, Flore mycologique de la France et des pays limitrophes. Paris 1888. (?)

Laugarnes [C. H. O.], det. E. Rostrup.

In the same place I have found *T. panaeolum*, but not *T. aggregatum*. I think it is doubtful whether *T. aggregatum* grows in this locality.

504. **T. conglobatum** (Vittadini) Saccardo. Bresadola, Fungi Tridentini, t. 32.

Hallormstaðir [P. L.]. — In the birch copses.

Cap 5—9 cm broad, convex, then irregularly depressed and wavy, tough, cartilaginous, margin incurved and mealy-floccose, occasionally with watergrey spots forming zones, otherwise greyish brown and grey when dry. Stipe white, fibrous-floccose, cylindrical, stuffed, cartilaginous. Gills greyish white, emarginate adnate, tough, edge entire, acute. — Spores spherical, 5 μ in diameter, colourless, verrucose-echinulate. Grows in dense clusters.

Melanoleuca Conrad et Maublanc.

505. **M. cognata** (Fries) Conrad et Maublanc, Icon. sel. Fung., Paris 1924, Pl. 271, var. **elatior** n. v.

Agaricus arcuatus* cognatus Fries, Epicr., p. 46.

Hallormstaðir [P. L.]. — On open grassy spots in birch copses.

Cap c. 8 cm broad, convex with a low rounded umbo, later crateriform with or without an umbo, yellow or pale brown along the margin (ranging from k 3 to g 7), darker at the centre, smooth and greasy. Stipe 12 cm high, 1—1.5 cm thick, increasing in thickness towards base, the upper part faintly sulcate and mealy, floccose, the lower part covered by white projecting hyphæ, the colour is greyish-brown (f 8); flesh of stem fibrillose finally becoming so soft that the upper part of the stem cannot support the cap, but bends at an acute angle, the cap becoming pendent. Gills c. 12 mm broad, crowded, thin, yellow with a red tinge (b 6), deeply emarginate or almost free. Spores colourless, ellipsoidal or acuminate below, minutely verrucose-echinulate, 9×5 μ. Cystidia lanceolate, up to 60×12 μ, bearing a lobate hood at apex.

The yellow form of Rickens *Tricholoma turritum* (Fries) seems to be identical with this.

Hebeloma Fries.

506. **H. crustuliniforme** (Bulliard) Fries, Epicr., p. 180.

Hallormstaðir, Hálsskógur and at Borg [P. L.]. — Common in the birch copses.

Cap 5—7 cm broad, plano-convex, with incurved margin, destitute of veil, pale brown to alutaceous; flesh thick, pale, smelling like radishes. Stipe cylindrical, but often with a somewhat bulbous base, white, flocculose-squamulose, mealy at the apex. Gills rounded towards the stem, at first pale, then clay-coloured, edge of gills irregularly toothed, in damp weather exuding small drops. Spores elliptic, rough, brown, 10—12× 6—7 μ. The cystidia at the edge of the gills hairshaped, or somewhat swollen at apex, sinuate.

507. **H. fastibile** Fries, Epicr., p. 178.

Egilsstaðir [P. L.]. — In birch copses.

Cap 5—8 cm broad, convex, with rounded obtuse umbo, glutinous, margin inrolled, flocculose, at first almost white, then palely alutaceous at centre. — Stipe cylindrical, bulbous at base, white, covered with a fibrillose layer, at the apex a ringshaped veil. Gills comparatively narrow, thin, emarginate, at first almost white, then pale chocolate, edge of gills white and toothed. — Spores narrowly ellipsoidal, pale brown, with one large drop in the middle, 11—13×5—6 μ. Cystidia at the edge of gills hair-shaped sinuate with swollen apex.

508. **H. sp.** (*H. hiemale* Bresadola, Icon. Myc. XV, Milano 1930, Tab. 715?).

Hallormstaðir [P. L.]. — In birch copses.

Cap 2—4 cm broad, plano-convex, slimy, centre brown (h 2), margin at first grey — covered by the veil — then fuscous (h 3). Stipe cylindrical or somewhat dilated at base, 7 cm long, 2—4 mm thick, rigid, brittle, hollow, at first white, then brown, longitudinally adpresso-fibrillose, apex mealy, as a rule a distinct ring. — Gills at first pale grey, then brown with dark dots, deeply emarginate, edge of gills minutely frayed. Spores ellipsoidal, smooth, pale, 10—12×5—6 μ. Edge of gills closely set with cystidia which are hair-shaped, but often swollen at the base or in the middle, 60×6—7 μ.

509. **H. mesophaeum** Fries, Epicr., p. 179.

Common on heaths and in birch copses in the areas examined.

Cap 4—5 cm broad, at first convex, but soon plane or even depressed, slimy, centre dark brown (h 2), margin clay-coloured (e 3), but long covered by a greyish white veil. Stipe cylindrical, often somewhat flexuose, hollow, rusty brown inside, covered on the outside with the remains of the greyish yellow veil and often bearing a lacerated ring. Gills at first fuscous, then clay-coloured (e 3), crowded, emarginate. Spores ellipsoidal, straight or faintly curved, brown, rough, 10×5—6 μ. Cystidia at edge of gills hairshaped, but more or less swollen at apex, 55—65×4—8 μ.

Inocybe Fries.

510. **I. descissa** Fries, Epicr., p. 174.

Hallormstaðir [P. L.]. — Among the grass in outfields.

Pileus 2—3 cm broad, convex, umbonate, cuticle radiately cracked and split and recurved at margin, the umbo cracked so as to assume a warty appearance, colour light brown (k 4). Stipe cylindrical or slightly dilated at base, pale, mealy at top, the remaining part finely striate-sulcate. Gills almost coloured like the pileus but somewhat lighter, not emarginate, but narrowly adnate. — Spores smooth, brown, oblique, slightly acuminate at one end, 1- or 2-guttulate, 9—11 × 5—5.5 μ. Cystidia both on the surface and at the edge of gills flaskshaped, apex coroniferous, c. 50×18 μ.

Fig. 4.
Inocybe descissa.
Cystidia and spores × 500.

511. **I. geophylla** (Sowerby) Fries, Syst. Myc. I, p. 258. Sowerby, t. 124.

Hallormstaðir and Egilsstaðir [P. L.].

Cap c. 2 cm broad, convex and umbonate or conical, surface dry, white, radiately fibrillose. Stipe cylindrical, but as a rule with a small bulb. at base. — Gills at first greyish white, then greyish clay-coloured, strongly rounded towards the stipe and adnate. Spores brown, smooth, ovoid or ellipsoidal, 1- or 2-guttulate, 8.5—9.5×5 μ. — Cystidia both on the surface and at the edge of gills subcylindrical or somewhat ventricose below with short stalk, apex coronate, 55—60×12 μ.

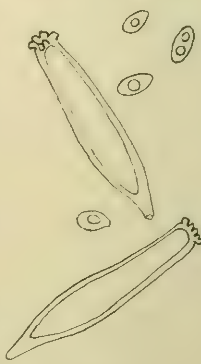


Fig. 5.
Inocybe geophylla.
Cystidia and spores × 500.

512. **I. hirtella** Bresadola, Fungi tridentini I, p. 52.

Glerá near Akureyri [P. L.]. — Littoral fields.

Cap 1.5—2.5 cm broad, conical, at first pale yellow, then tawny or brown (g 2 to g 6), apex smooth, rest of cap at first minutely squamulose and lacerate, then longitudinally disunited in fibrils. Stipe cylindrical, bulbous, white or faintly yellow, minutely pubescent flocculose, stuffed. — Gills at first almost white, then coloured like the cap, with white frayed edges, narrowly adnate. — Spores ovoid or ellipsoidal, finely punctate, brown, 8.8—9.5×5—6 μ, 1- or 2-guttulate. Cystidia at edge of gills and on the surface short and broadly flaskshaped, apex coronate, 40×15—20 μ, in addition short clubshaped cells at the edge of the gills.

513. **I. lacera** Fries, Syst. Myc. I, p. 257.

Egilsstaðir, Hallormstaðir, Mývatn, Laxárdalur, Reykjadalur, Ljósavatnsskarð and Glerá (Akureyri) [P. L.]. — Among the grass in littoral fields, in sandy river valleys and outfields.

Cap c. 3 cm broad, convex or plano-convex with a very conspicuous umbo, at first crisped-squamulose below the even summit, then splitting deeply down into the flesh, ground colour brown (h 2) or yellowish brown (e 3), but as a rule with a greyish tinge owing to the coating. Stipe cylindrical or somewhat dilated at base, internally brown, fuscous

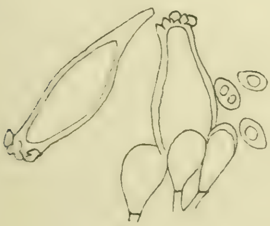


Fig. 6.
Inocybe hirtella.
Sterile cells, cystidia and spores × 500.

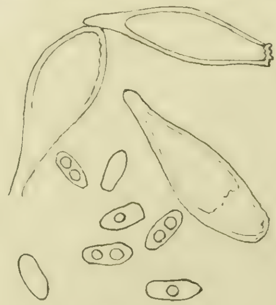


Fig. 7.
Inocybe lacera.
Cystidia and spores × 500.

externally, covered with fuscous fibrils and scurf, apex not or only indistinctly mealy. — Gills moderately crowded, broad, ventricose, obtusely adnate, colour about k 4. — Spores smooth, brown, irregular in form, mostly shaped like a projectile, 1- or 2-guttulate, $13-16 \times 6-7.5\ \mu$. — Cystidia at the edge and on the face of the gills flaskshaped with coronate apex or fusiform with an even and rounded apex, $48-60 \times 15-22\ \mu$.

514. **I. abjecta** Karsten, Hattsvampar I, p. 456.

Hallormstaðir. — Among moss on peaty soil with an admixture of sand.

Pileus 15—18 mm broad, plano-convex, umbonate, radiately fibrillose, at length splitting at margin, brown (h 3 to g 7), covered with a thin lacerate-fibrose white layer forming greyish-white hair-like scales at margin. — Stipe cylindrical, 4—5 cm high, 1—2 mm thick, somewhat flexuose, firm, stuffed, floccose, pale reddish-brown (k 2 to g 6). — Gills distant, anteriorly 3 mm broad, tapering towards the stipe, emarginate, margin denticulate, pale reddish-brown (k 1 to j 1). — Spores brown, smooth, pip-shaped, 1-guttulate, $8-9.5 \times 5-6\ \mu$. — Cystidia both on the face and at the edge of gills flaskshaped with obtuse more or less coronate apex. At edge of gills also shortly clavate cells.

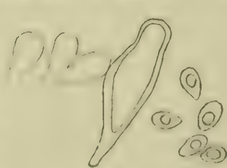


Fig. 8.
Inocybe abjecta
Sterile cells, Cystidia and spores, × 500.

515. **I. maculata** Boudier, Société botanique de France, 1885, p. 282.

Lava fields (Rhaun) near the south end of Mývatn, Laxárdalur, Reykjadalur, sandy meadows near Ljósavatn, littoral pasture near Akureyri [P. L.].

Cap 3—5 cm broad, at first campanulate with incurved margin, then almost plane, yellowish brown (e 3), covered with a thin white layer, subsequently splitting, at centre the cracks penetrate into the white flesh, making this area grey and verrucose. Stipe short (2—3 cm × 4—6 mm), somewhat marginato-bulbose, stuffed, at first white, then coloured like the cap, mealy above, the rest adpresso-fibrous. — Gills emarginate or nearly free, at first pale, then pale olive-brown with paler edge. — Spores brown, smooth, from ovoid to reniform, 1- or 2-guttulate, 9—11.5×5—6.5 μ. — Cystidia both at the edge and surface of the gills, fusiform, apex coronate, 44—50×16—24 μ.

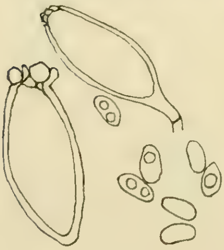


Fig. 9.
Inocybe maculata.
Cystidia and spores × 500.

Note. *I. maculata* Boudier differs from *I. brunnea* Quélet: 1) The surface of the cap is paler and subsquamulose, 2) it has genuine cystidia, 3) broader spores.

516. **I. rimosa** (Bulliard) Fries sensu Bataille. Fries Hym. Eur., p. 232. — Bulliard Champ., t. 388.

Akureyri. — Grows amongst grass, moss and Salix herbacea in littoral pastures.

Pileus 3—4 cm broad, convex, obtusely gibbous, entirely clothed with silky fibres, at length cracked at the margin which projects beyond the edge of gills and in young pilei is connected with the stipe by a fibrillose veil. The colour is brown (h 2 to h 3), the flesh white. Stipe c. 3 cm long, 4—5 mm thick, thinner at apex and somewhat dilated at base, stuffed, pale reddish brown, in young pilei with a fugacious ring on a level with the margin of cap. — Gills broadest at the margin of cap, deeply emarginate, at first creamcoloured (e 5), then brown (h 3), edge of gills white and toothed. — Spores brown, smooth, ellipsoidal or ovoid, 11.5—13.5×6.5—7.5 μ. — Cystidia both at the edge and on the surface of the gills and on the upper part of the stipe, cylindrical or elongate flaskshaped, apex coronate, 65—75×13—19 μ.

517. **I. umbonata** Quélet, sensu Ricken, Die Blätterpilze, p. 106.

Seydisfjörður [P. L.]. — Among mosses in a bog.

Pileus 2—3 cm broad, plano-convex, with conspicuous as a rule acute umbo, radiately sericeo-fibrillose, light brown (h 4), slimy. Stipe 3 cm long, 2—3 mm thick, cylindrical, pierced by a slender canal, coloured like the cap but paler, mealy at apex, otherwise naked, smooth. — Spores brown, smooth, ellipsoidal, 8—10×5 μ. — Cystidia both at edge and on face of gills fusiform, apex coronate, 30—35×12—15 μ.

518. **I. sp.**

Hallormstaðir [P. L.]. — Among mosses and grass in a bog.

Pileus 4—5 cm broad, plano-convex, floccosely fibrillose, not crisped-felted and not radiately cracked, tawny but with a fibrous white coating densest in the centre. — Stipe 4 cm long, 8—10 mm thick, stuffed or later

pierced, with a frayed ring like a *Telamonia*, above the ring yellow (l 4) and mealy, below ring of the colour k 2, towards the base sulcate and dilated. — Gills broad, emarginate, cinnamon, with yellow frayed edge. — Spores brown, smooth, ellipsoidal, the greater part 8—9×5 μ, a few 10—11×5.5 μ and very few 7×4.5 μ. No coronate cystidia, but edge of gills densely beset with vesiculously inflated cells, some of which contain a yellow juice.

Allied to *I. dulcamara*, but distinguished by form and colour.

519. **I. fastigiata** Schaeffer Fries, Epicr., p. 174. Schaeffer Fung. Icon., t. 26.

Egilsstaðir [P. L.].

Pileus 4—6 cm broad, at first conical, then expanded with a conspicuous umbo, cuticle radiately fibrillose and rimose except in the centre where it is entire and even, colour of margin l 2 to k 2, colour of the umbo k 3 to f 8. Flesh nearly white. Stipe cylindrical or somewhat attenuated at apex, stuffed, pale, fibrillose-lacerate. Gills rounded towards stipe, narrowly adnate or nearly free, greyish yellow, then olivaceous, edge of gills dentate-fimbriate at length nearly even. — Spores brown, smooth, broadly ellipsoidal or ovate, a few reniform, as a rule 2-guttulate, 11—12 × 6.5—8 μ (a very few up to 15 × 7.8 μ.) No coronate cystidia, but numerous thick-walled, clavate or fusiform cells at the edge of the gills.

520. **I. calamistrata** Fries, Syst. Myc. I, p. 256.

Seyðisfjörður, Lagarfljótsdalur, Laxárdalur, Akureyri [P. L.]. — In littoral fields, sandy meadows, and outfields.

Pileus 2—4 cm broad, campanulate, somewhat hygrophanous, densely covered with squarrose scales, when moist the colour of the pileus is f 6, when dry f 8. A similar change takes place in the colour of the flesh, which is a pale greenish blue when moist (a 8), when dry b 8. When crushed the flesh colours red (n 7). — Stipe cylindrical, 2—4 cm high, 3—4 mm thick, occasionally flexuose, mealy above, otherwise densely squamulose and brown, at base strongly blue-green. — Gills broad, deeply emarginate, decurrent by a tooth, edge of gills fimbriate and thick, colour at first pale brown, then rusty. — Spores broadly ellipsoidal or ovoid, sligthly curved, smooth, brown, 1- to 3-guttulate, 10—16.5 × 6—8 μ. No coronate cystidia, but the edge of gills closely beset with clavate, swollen cells.

Fig. 10.
Inocybe calamistrata.
Sterile cells and spores, × 500.

521. **I. dulcamara, f. autumnalis** Albertini et Schweinitz Fries, Hym. Eur., p. 228.

Hallormstaðir, Mývatn, Reykjadalur, Ljósavatn and Akureyri [P. L.]. — Common in as well as outside birch copses among mosses and grass.

Pileus 2—4 cm broad, convex, umbonate, tomentose-squamose, with a distinct veil, olivaceous yellow (between h 3 and o 5); flesh pale olive yellow. — Stipe cylindrical, at first stuffed, then hollow, felted, mealy above, concolorous, but paler. — Gills ventricose, obtusely adnate, concolorous, at length brown. — Spores ellipsoidal, curved, smooth, pale brown, with or without guttulae, 8—11 × 5—6 μ. No coronate cystidia, but clavate, smooth cells at the edges of gills.

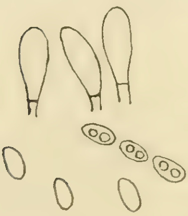


Fig. 11.
Inocybe dulcamara.
Sterile cells and spores × 500.

522. **I. caesariata** Fries, Hym. Eur., p. 234.

Hallormstaðir, Mývatn [P. L.]. — On knolls in lava fields, among mosses and in birch copses.

Pileus 2—3 cm broad, convex, gibbous, slightly tomentose-fibrillose, flaxen. Margin somewhat incurved, covered with white fibres. Stipe 5—6 cm long, 3—5 mm thick, slightly expanded below, pale flaxen or nearly white, longitudinally fibrous or slightly squarrose, mealy at apex. — Gills slightly emarginate, adnate, with decurrent tooth, at first pale, then concolorous. Edge of gills white and fibrillose. — Spores ellipsoidal, ovoid, 1- or 2-guttulate, smooth, brown, 8—9 × 5.6 μ. No coronate cystidia, but at the edge of gills clavate, smooth cells, often with transverse septa.

Fig. 12.
Inocybe caesariata.
Sterile cells and spores × 500.

523. **I. conica** n. sp,

Hallormstaðir [P. L.]. — On dry grassy hills.

Pileus regularly conical, 1.5—2 cm long and broad, cuticle radiately resolved into fine fibrils so dense that the cap seems smooth, almost as in I. geophylla, tawny (between h 3 and e 3) with a silky lustre. — Stipe cylindrical, stuffed, 2—2.5 mm thick, pale reddish-brown above and nearly naked, pale lemon-colour below (l 1). — Gills ascending, very narrowly adnate, pale lemon colour (l 1), edge white and fimbriate. — Spores ellipsoidal, smooth, brown, 1-guttulate, 9—11.2 × 6—6.5 μ. No coronate cystidia, but fusiform smooth cells, swollen at apex, at the edge of the gills.

Allied to *I. geophylla*, but no coronate cystidia and larger spores.

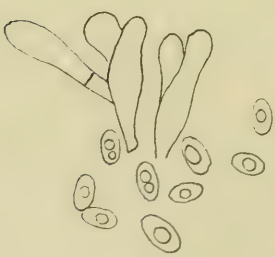


Fig 13.
Inocybe conica n. sp.
Sterile cells and spores, × 500.

524. **I. hjulca** (Fries) Bresadola, Fungi tridentini, t. 122, f. 2.

Mývatn, Glerá (Akureyri) [P. L.]. — Among grass in littoral fields and lava fields.

Pileus 2—3 cm broad, convex, umbonate, cuticle broken up into radiate fibrils, the umbo even and greyish white or fuscous (h 3). — Stipe cylindrical, marginato-bulbose, stuffed, fibrous, mealy above, in the middle palely incarnate (l 7),

white above and below. — Gills nearly free, at first grey with a reddish tinge (c 7), then brown, edge of gills toothed. — Spores oblong, from rectangular to irregularly angular, without prominent prickles or warts, brown, 1- or 2-guttulate, 8—10×5—6.5 μ. — At the edge and on the face of the gills fusiform and coronate cystidia, 50—72 × 16—21 μ.

Fig. 14.

Inocybe hjulca.

Cystidia and spores, × 500.

525. **I. praetervisa** Quélet, Flore myc. Fr., p. 99.

Seyðisfjörður, Lagarfljótsdalur, Laxárdalur [P. L.]. — In open grassy spots, in littoral pastures and in sandy meadows.

Pileus 3—6 cm broad, at first conical, then expanded and umbonate, cuticle radiately rimose and fibrillose, tawny (e 3), when fresh viscid, flesh thin. — Stipe cylindrical, marginato-bulbose, stuffed, at first white, then flaxen (k 2) in the middle, above floccosely hairy, otherwise naked, longitudinally sulcate-striate. Gills rather crowded, ventricose, emarginate, with denticulate edge, at first grey (g 5 to i 2), then brown. — Spores brown, oblong, angular, verrucose, 8.5—11×5.5—6.5 μ. — At edge and on face of gills fusiform coronate cystidia 60—70×15—16 μ.

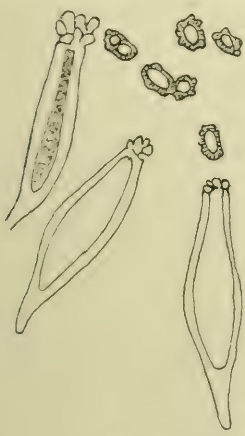


Fig. 15.

Inocybe praetervisa.

Cystidia and spores × 500.

526. **I. sp.**

Egilsstaðir [P. L.]. — On knolls in outfields and bogs.

Pileus 1.5—2.5 cm broad, at first conico-campanulate, then expanded with a conspicuous verruciform umbo, radiately adpressedly fibrous, split at the margin, dark reddish brown (g 8), somewhat shining. Stipe cylindrical, slightly bulbous at base, 3.5—4 cm long, 2—3 mm thick, rigid, firm and flexuose, greyish mealy at apex, otherwise nearly naked, only slightly fibrous, reddish brown (h 2). Gills at first grey, then reddish grey-brown, ventricose, deeply emarginate, edge almost entire and sharp. — Spores brown, oblong, angular, almost without warts, 8.5—9.5×5.5—6.5 μ. — Fusiform coronate cystidia both at the edge and on the face of the gills 50—60 ×15—19 μ.

Allied to I. proximella Karsten, but spores with smaller warts.

527. **I. decipiens** Bresadola, Fungi tridentini II, p. 13, t. 118.

Hallormstaðir [P. L.]. — In sandy, grassy spots in birch copses.

Pileus 3—4 cm broad, convex, conspicuously umbonate, radiately rimose and fibrillose, the umbo even, tawny (k 5). — Stipe cylindrical, marginato-bulbose, stuffed, 4—5 cm high, 6—8 mm thick, white growing

yellowish. Apex mealy, otherwise naked, but slightly sulcate. — Gills obtusely adnate, with denticulate edge, at first greyish white, then fuscous with pale margin. — Spores oblong, tapering towards one end, flexuose-angular, with low verrucose thickenings of the membrane which is tawny, $10-13 \times 6.4-7.5\ \mu$. Fusiform, coronate cystidia at edge and on face of gills, $45-60 \times 14-16\ \mu$ and also clavate, smooth cells at edge of gills.

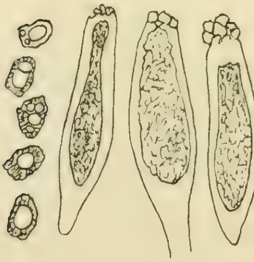


Fig. 16.
Inocybe decipiens.
Cystidia and spores × 500.

528. **I. trechispora** (Berkeley) Bresadola, Icon. Mycol. XVI, t. 766, 1930.

I. scabella Cooke sensu Roger Heim, Le genre Inocybe, Paris 1931, p. 401.

Laxárdalur near Mývatn, Glerá near Akureyri [P. L.]. — On sandy, grassy and mossy flat stretches along the rivers.

Pileus 7—10 mm broad and almost as high, conico-campanulate, shortly squarrosely tomentose, reddish brown (j 5), summit occasionally grey; the slightly incurved margin is pale, the almost white gills being visible below it. — Stipe cylindrical with spherical bulb, 2 cm high and 1—1.5 mm thick, white above and slightly mealy, pale brown in the middle, the bulb white; gills ascending, acutely adnate, white edge, at first greyish white, then brown-grey, at length brown. — Spores irregularly 5- or 6-angular with low rounded warts, brown, 1-guttulate, $8-9.6 \times 6.5-8\ \mu$. — Cystidia — both at edge and on face of gills — fusiform with coronate apex, $48-60 \times 16.5-19\ \mu$.

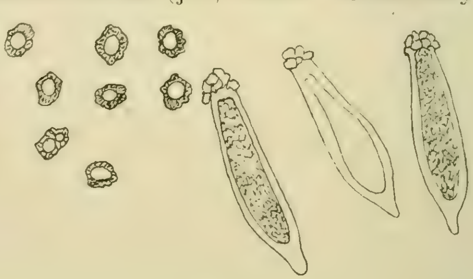


Fig. 17.
Inocybe trechispora.
Cystidia and spores, × 500.

529. **I. grammata** Quélet (?), Flore myc. Fr., p. 100.

Eyjolfstaðir and Hallormstaðir [P. L.]. — In birch copses.

Fig. 18.
Inocybe grammata?
Cystidia and spores × 500.

Pileus 4—5 cm broad, flatly conical with rounded summit, cuticle radiately rimose, viscid, fuscous, summit and margin pale grey, shining when dry. — Stipe short and thick, bulbous, in the middle rose-coloured (m 2). Apex farinaceous and sulcate, bulb white. Flesh of cap cream-coloured, of stipe pale orange (e 6). Gills broad, emarginate, grey, then brown, edge fimbriate. Spores brown, oblong, approach-

ing parallelogram form, with few low warts, $9-13 \times 5-6.5\ \mu$. — Cystidia — both at edge and on face of gills — broadly fusiform, coronate, $40-52 \times 14-20\ \mu$. Differs from *I. grammata* Quélet in the more fuscous colour of the pileus.

Cortinarius Fries.

530. **C.** (Hydrocybe) **tortuosus** Fries, Syst. Myc. I, p. 235.

Hallormstaðir [P. L.]. — In birch copses.

Cap 2.5—4 cm broad, convex, umbonate, hygrophanous, when fresh dark chestnut-colour (c 3), when dry a lighter brown; margin covered with a silky white coating; flesh thin. — Stipe cylindrical, hollow, flexuose and twisted, brittle, lilac violet at apex, covered with a silky white coating, brown inside. — Gills ascending, emarginate adnate, often with a decurrent tooth, brown with a paler edge, assuming a red tinge when broken. Spores brown, ellipsoidal, punctate, $8-10.5 \times 5-6\ \mu$.

531. **C.** (Hydrocybe) **decipiens** (Persoon) Fries, Epicr., p. 312.

Agaricus decipiens Persoon, Synops. meth. fung., p. 298.

Egilsstaðir [P. L.]. — In birch copses.

Pileus c. 2 cm broad, at first conico-campanulate, then expanded with a distinct umbo, hygrophanous, with thin flesh or skin-like margin sericeo-fibrous, chestnut brown (c 4), umbo darker (c 3). — Stipe cylindrical, occasionally dilated at base, rigid, 6 cm high, 2—3 mm thick, reddish brown internally, externally covered with white silky fibrils, which here and there — especially at the base of stipe — are tinged with rose colour. — Gills thin, crowded, emarginate adnate, with a decurrent tooth, at first pale reddish yellow, then cinnamon. — Spores tawny, ellipsoidal with obtuse ends, sharply and finely punctate, $7.5-9 \times 4.5-5\ \mu$.

532. **C.** (Telamonia) **incisus** (Persoon) Fries, Syst. Myc. I, p. 213.

Agaricus incisus Persoon, Synops. meth. fung., p. 310.

Hallormstaðir, Akureyri [P. L.]. — On knolls in swamps along Hörgá and in birch copses.

Pileus 2—4 cm broad, convex, acutely umbonate, hygrophanous, dark brown at centre (f 4), paler along the margin (c 3), cuticle at first even and clothed with crisped grey hair-like scales, then radiately cracked and broken up into fibrils. — Stipe 3—4 cm high, 3—4 mm thick, cylindrical or dilated at base, coloured like margin of cap, rust-coloured internally, externally covered by a volva ending on a level with margin of cap in a distinct and lacerated ring. — Gills dark cinnamon, emarginate 3—4 mm broad. — Spores cinnamon-coloured, broadly ellipsoidal, punctate, $9 \times 5.6\ \mu$.

533. **C.** (Telamonia) **helvelloides** Fries, var. **islandica** n. var.

Egilsstaðir, Mývatn, Akureyri [P. L.]. — In the littoral field along Glerá, in sandy meadows near Laxá and in meadows by Lagarfljót.

Pileus 1—2 cm broad, convex, often with undulate-dentate margin, hygrophanous, tawny when moist (k 5), when dry more yellow (l 5), cuticle even, covered with short yellow fibres. Flesh saffron-yellow or rusty red, very thin, taste bitter. Stipe cylindrical or slightly expanded below, pierced by a slender canal above, 2 cm long, 1.5—2.5 mm thick, the lower two-thirds covered with a fibrous torn, tawny sheath, ending in a raised very conspicuous ring, above which the stipe is shining, smooth and purple violet (o 2 to o 3). — Gills rather broad, plane, emarginate-adnate, rather thick and distant, at first pale purple (n 8), then cinnamon. Basidia obtusely clavate, 6—7 μ broad, 4-spored. — Spores cinnamon-coloured, ellipsoidal, punctate, 1-guttulate, 8—9×5—5.2 μ, some few spores up to 10×5.2 μ. Caps breaking out in clusters or gregarious.

Distinguished by the clothing of the pileus, colour of the stem and the small size of the pileus.

534. **C.** (Telamonia) **hemitrichus** (Persoon) Fries, Epicr., p. 302.

Agaricus hemitrichus Persoon, Synopsis meth. fungorum, p. 296.

Hallormstaðir [P. L.]. — In birch copses, not common.

Pileus 3—5 cm broad, convex, gibbous, hygrophanous, dark brown (between g 8 and f 6), covered with white hair-like scales especially along the margin, veil strongly developed and pendent from the margin. Stipe 3—7 cm long, 4—5 mm thick, cylindrical, hollow, internally brown, externally densely covered with the white floccose velum, often terminating in a ring above. — Gills rounded adnate, crowded, toothed, at first greyish white, then cinnamon. — Spores cinnamon-brown, slightly punctate, ellipsoidal, 8×4—4.5 μ.

535. **C.** (Telamonia) **flexipes** (Persoon) Fries, Epicr., p. 300.

Egilsstaðir [P. L.]. — In birch copses.

Pileus 1.5—3 cm broad, at first conical, then expanded with verruciform centre, hygrophanous, at first dark violet, then reddish grey (k 4), the centre long remaining dark, cuticle covered with a white fibrillose layer, dense and fimbrillate along the margin. — Stipe cylindrical, flexuose, stuffed, 4—7 cm high, 3—4 mm thick, at first all violet, then only violet at apex, constantly covered with an often zone-like, fibrillose white layer. — Gills rather distant, emarginate-adnate, at first violet, then reddish grey and finally cinnamon. — Spores nearly smooth, brown, ellipsoidal, 8—9.6 × 4.5—5 μ.

536. **C.** (Telamonia) **rigidus** (Scopoli) Fries, Epicr., p. 302.

Agaricus rigidus Scopoli, Flora Carniolica, p. 456.

Hallormstaðir [P. L.]. — In birch copses.

Pileus 2—3 cm broad, convex, umbonate, brown (h 3), when dry paler brown, margin straightened, at first covered with white fibrils, then naked and glabrous or with the cuticle lacerate-rimose. — Stipe cylindrical, 5—7 cm high, 2—4 mm thick, filled with a fibrillose tawny mass, rigid, somewhat flexuose, externally concolorous, but partly covered

by a white fibrillose velum, as a rule forming a ring. — Gills 2—3 mm broad, adnate in their entire breadth or somewhat emarginate, tawny (l 3), then cinnamon-brown. — Spores brown, punctate, varying in size, but on the whole rather small, 6—8.5×3—4.5 μ.

537. **C.** (Telamonia) **gentilis** Fries, Epicr., p. 297.

Eyolfsstaðir [P. L.]. — In birch copses.

Pileus 2.5—4 cm broad, conico-campanulate, acutely umbonate, hygrophanous, tawny (k 3), shining, along margin covered with the remains of the pure yellow or citron-yellow veil, for the rest naked and glabrous, when dry the whole cap is pale yellow. — Stipe cylindrical, hollow, 5—8 cm long, 3—4 mm thick, internally and externally coloured like the cap and covered with a yellow velum forming a ring. — Gills thick, distant, obtusely adnate, at first yellow (l 5), then cinnamon. — Spores broadly ellipsoidal, punctate, brown, 8—8.5×5.5—6 μ.

538. **C.** (Telamonia) **biformis** Fries, Epicr., p. 299.

Egilsstaðir [P. L.]. — In birch copses.

Pileus 5—7 cm broad, at first convex, then expanded, obtusely umbonate, but slightly hygrophanous, brown, covered only along margin with white fibres. Flesh thin except at centre, brownish. — Stipe cylindrical, pale, white velum covering the surface to the oblique ring terminating in a brownish edge. — Gills broad, rather crowded, emarginate edge of gills undulate-dentate, at first grey then cinnamon. — Spores ellipsoidal, brown, slightly punctate, 8—9 × 4—5 μ.

Grows in dense clusters round the base of birches.

539. **C.** (Telamonia) **helvolus** (Bulliard) Fries, Epicr., p. 296.

Reykjahlíð (Mývatn) [P. L.]. — In birch copses on lava fields.

Pileus 3—6 cm broad, soon flatly expanded and somewhat depressed about the low rounded umbo, hygrophanous, brown, at length radiately broken up into fibres like an Inocybe. — Stipe cylindrical with somewhat dilated base, covered by an at first white, then brown velum forming a ring, medullated, at length hollow, internally, and finally externally, brown. — Gills fairly distant, thick, emarginate, cinnamon. — Spores brown, somewhat almond-shaped, sharply punctate, 8—10 × 5—6 μ.

540. **C.** (Telamonia) **bulbosus** (Sowerby) Fries, Epicr., p. 292.

Agaricus bullosus Sowerby, t. 130.

Hallormstaðir [P. L.]. — In birch copses.

Pileus 5—7 cm broad, campanulate, with projecting, broad and rounded umbo, margin incurved and fibrous fimbrillate, only slightly hygrophanous, brown (k 6 to k 7), flesh thick, especially at centre. — Stipe 5—7 cm long, bulbous, covered by a white, fibrous velum. Flesh of stipe pale brown or white, but of the bulb saffron-yellow. — Gills broad, adnate, dark brown, then cinnamon. — Spores ellipsoidal, brown, punctate, 8—9 ×5—5.5 μ.

541. **C.** (Telamonia?) **sp.**

Skútustaðir (Mývatn) [P. L.]. — On knolls in lava fields.

Pileus 2 cm broad and high, conico-campanulate, somewhat hygrophanous, dark reddish brown (j 3), cuticle at length minutely cracked crosswise and lengthwise, and finely tessellated, margin straightened, covered with white fibres, at length with short cracks, rendering it dentate. — Stipe dilated below, pale brown, and covered with a white, fibrous velum, which does not form a ring. — Gills very broad, emarginate adnate, brown. — Spores brown, echinulate-verrucose, broadly ellipsoidal, 8—9 × 6 μ.

Allied to *C. stemmatus* Fries, but differing especially in the dilated base of the stem.

542. **C.** (Dermocybe) **cinnamomeus** (Linné) Fries, Epicr., p. 288.

Lagarfljót near Vallanes [P. L.]. — In sandy moor-like meadows.

Pileus 3—5 cm broad, plano-convex, dry, tawny (k 5), covered with fine adpressed fibres. — Stipe cylindrical, lemon-yellow (b 7); veil coloured like the stipe. — Gills broad, emarginate, lemon-yellow (b 7), then cinnamon-brown. — Spores brown, ellipsoidal, slightly verrucose, 8—9 × 4.5—5 μ.

543. **C.** (Dermocybe) **anomalus** Fries, Epicr., p. 286.

Egilsstaðir [P. L.]. — In birch copses.

Pileus 4—5 cm broad, plano-convex with incurved margin, brown in centre (g 7), pale violet at margin (o 7) and covered with fibrous remains of the veil. — Stipe cylindric-clavate, the base being dilated, covered by a yellowish white fibrous layer, pale violet above (o 7). — Gills at first pale violet (o 7) then cinnamon, emarginate, margin white and dentate. — Spores brown, punctate, subspherical, 8—8.5 × 7 μ.

544. **C.** (Inoloma) **Bulliardii** (Persoon) — sensu R. Maire.

Agricus Bulliardii Persoon, Synops. meth. fung., p. 289.

Egilsstaðir [P. L.]. — In birch copses.

Pileus 5—7 cm broad, campanulate, with a prominent, broad, and rounded umbo, fibrous, dark brownish red (j 3), shining. — Stipe cylindrical with clavate swollen base, whitish but covered with red (m 1) threads, here and there confluent in red areas, but not forming red bands as in Cortinarius armillatus, flesh of cap and stipe pale orange (k 1). — Gills rather crowded, emarginate adnate, purple brown to yellow rust-brown with whitish dentate edge. — Spores ellipsoidal, brown, punctate, 8—9 × 5 μ.

545. **C.** (Phlegmacium) **porphyropus** (Alb. et Schw.) Fries, Epicr., p. 271.

Eyjolfsstaðir [P. L.]. — In birch copses.

Pileus 4—7 cm broad, plano-convex, sometimes with a low umbo, margin thin, viscid, slimy, covered with innate grey fibres, clay-coloured (g 7). — Stipe cylindrical with somewhat swollen base, at first violet, then

yellowish white, filled with a loose pith, then hollow. — Gills fairly crowded, emarginate, at first purple-violet, then cinnamon-coloured. — Both cap, stipe, and gills assume a purple-violet (n 3) tint when bruised. — Spores brown, roughly punctate, ellipsoidal, $10-12 \times 6\ \mu$.

546. **C.** (Phlegmacium) **latus** (Persoon) Quélet.

Agaricus latus Persoon, Synops. meth. fung., p. 176.

Eyjolfsstaðir [P. L.]. — In birch copses.

Cap 5—8 cm broad, campanulate, fleshy, firm, viscid, pale ochraceous or alutaceous, in the young, fresh state almost white. — Stipe short, c. 5 cm high, thick, especially below (c. 3 cm), stuffed, firm, white, veil well developed, white. — Gills crowded, adnate, white or greyish-white with a white margin. — Spores obliquely ellipsoidal, one end acuminate, brown, punctate, $13 \times 6-6.5\ \mu$.

547. **C.** (Myxacium) **collinitus** (Persoon) Fries, Epicr., p. 274.

Agaricus collinitus Persoon, Synops. meth. fung., p. 281.

Hallormstaðir and Egilsstaðir [P. L.].

Pileus 6—8 cm broad, campanulate, very slimy, shining when dry, yellow-orange (b 5), in the centre brown-orange (k 5). — Stipe cylindrical, stuffed, covered by a slimy violet velum, subsequently splitting up into ring-shaped areas, between which the cuticle is brown and floccose-squamulose, height 10—12 cm, thickness 12—16 mm. — Gills broad, emarginate, with a decurrent tooth, at first a brownish orange (k 5), then cinnamon-brown with a white margin. — Spores brown, verrucose, obliquely ellipsoidal, $13 \times 6-7\ \mu$.

Amanitopsis Roze.

548. **A. vaginata** (Bulliard) Roze, var. **fulva** (Schaeffer).

Agaricus fulvus Schaeffer, Fung. Ic., t. 95.

Eyjolfsstaðir (c. 4 km east of Vallanes near Lagarfljót) [P. L.]. — In birch copses.

Pileus 6—8 cm broad, campanulate, cuticle viscid and naked, orange-yellow (b 5 to g 3), margin sulcate. — Stipe elongate-conical, 8—10 cm high, 1—1.5 cm thick, somewhat bulbous, hollow, white, floccose-squamulose, no ring, the lower third of the stipe covered by a loose sheath. — Gills white with a yellow tinge, free, edge covered by a mealy-floccose layer, consisting as well as the scales on the stipe of spherical cells, 20—40 μ in diameter, as a rule prolonged into a short stalk-like apex. The collected specimens were sterile.

Note. This species is also given in E. Rostrups »Islands Svampe«, collected by Helgi Jónsson at Stykkishólmur, but as there is no description, it is not possible to see whether it is the same form of this polymorphous species as the present.

Pholiota Fries.

549. **Ph. togularis** (Bulliard) Fries, sensu Ricken.

Agaricus togularis Bulliard, Hist. champ. t. 595, f. 2.

Hallormstaðir [P. L.]. — Among grass in open parts of birch copses.

Pileus campanulate, 2 cm broad, 1.5 mm long, hygrophanous, flesh thin, pellucidly striate, ochraceous (k 3), brown in the centre (k 6), lighter when dry and slightly rugose. — Stipe cylindrical, 7 cm long, 1—2 mm thick, slightly bulbous, hollow, pale and mealy above, rusty and fibrous below. — Gills ascending, crowded, tawny, margin white and dentate. — The veil forms a membranaceous white ring, radiately striate-plicate on the upper side, movable, central. — Spores elongate-ovoid, brown, smooth, germ pore distinct, 12—13 × 6 μ. — Edge of gills beset with flask-shaped cystidia, acuminate above.

550. **Ph. praecox** (Persoon) Fries, Hym. Eur., p. 217.

Agaricus praecox Persoon, Synops. meth. fung., p. 420.

Hálsskógur in Fnjóskadalur [P. L.]. — In birch copses.

Pileus convex, obtuse, 4—5 cm broad, at first white, then yellowish-white or cream-coloured, even, at length minutely fringed along the margin. — Stipe cylindrical, 5 cm long, 5 mm thick, white with a raised skin-like ring. — Gills at first almost white, then rusty brown, emarginate-adnate, with a decurrent tooth. Flesh soft, white, smelling and tasting like flour. — Spores ovoid, brown, smooth, 8—9.5×5—6 μ. — Edge of gills beset with scattered, shortly and broadly flask-shaped cystidia, 40—45 × 18—20 μ.

551. **Ph. mutabilis** (Schaeffer) Fries, Syst. Myc. I, p. 245.

Agaricus mutabilis Schaeffer, t. 9.

Hallormstaðir. Rare [P. L.]. — Grows in clusters on stumps in birch copses.

Pileus 5—6 cm broad, plano-convex, obtusely gibbous, hygrophanous, brown (h 3), paler when dry, especially at the margin, (b 7). — Stipe cylindrical somewhat flexuose, at length hollow, bearing a skin-like, persistent ring, below which it is rusty brown and squamulose, above the ring naked, pale brown and sulcate. — Gills crowded, thin, tough, adnato-decurrent. Flesh thin, pale brown, taste mild, odour none. — Spores ovoid, brown, smooth, 6—7 × 4—4.5 μ. — At edge of gills hair-shaped, 4 μ broad cystidia.

552. **Ph. marginata** (Batsch) Fries(?), Hym. Eur., p. 225.

Meadows near Vallanes (Lagarfljót), a bog at Ljósavatn, the shore at Akureyri and Laugarnes near Reykjavík [P. L.]. — On peaty, damp soil in bogs and river valleys, but not in birch copses.

Pileus 2—5 cm broad, at first campanulate, with a thin incurved margin, then plano-convex, sometimes with a small umbo, hygrophanous,

margin pellucidly striate, shining, orange-brown when moist (between f 8 and b 5), paler when dry (b 6). — Stipe cylindrical, hollow, pale brown, covered with adpressed greyish-white fibres below, bearing above a skin-like pale rusty yellow ring adpressed to the stipe. — Gills narrow, crowded, broadly adnate or somewhat emarginate, yellowish brown, edge dentate. — Spores brown, slightly punctate, broadly ellipsoidal, the greater part 10—10.5 × 6—6.5 μ, a few up to 12 × 6.5 μ. — Cystidia at edge of gills cylindrical to flask-shaped.

In reality the fungus only differs from *Ph. marginata* in the dimensions of the spores.

Flammula Fries.

553. **F. alnicola** Fries, Syst. Myc. I, p. 250.

Hallormstaðir [P. L.]. — Grows in clusters at the foot of birch trunks.

Pileus c. 4 cm broad, convex with an involute margin, moist, viscid, yellow (l 4), at first covered by a thin, white, mealy layer, then naked, margin joined to the stipe by a rather thick, white veil, which subsequently splits and hangs down from the margin. Flesh pale yellow. — Stipe cylindrical, concolorous above, covered below with rusty brown fibres or scales. — Gills concolorous, emarginate-adnate, tough, edge white and dentate-floccose. — Spores ellipsoidal, smooth, brown 8—9 × 4.5 μ. — Edge of gills beset with sterile hyphae swollen at the apex.

Naucória Fries.

554. **N. myosotis** Fries, Hym. Eur., p. 261.

On the edges of turf-pits at Seyðisfjörður and on the edges of ditches in a bog at Laugarnes near Reykjavík [P. L.].

Pileus 3—6 cm broad, at first conico-campanulate, then expanded, more or less conspicuously umbonate, margin in young specimens joined to the stipe by a well-developed, yellowish-white veil; disc olive-brown (f 6), margin paler. — Stipe cylindrical, 7—12 cm long, 4—8 mm thick, frequently attenuated into a rootshaped base, fistulose, tough, yellowish-white above (b 8) with a ring in young specimens, more brownish below, everywhere fibrous and viscid. — Gills broadly adnate, at first yellowish-white (b 8), then dark-brown, margin serrate. — Spores brown, smooth, ellipsoidal or somewhat oblique, 15—17 × 7.5—8.5 μ. — Edge of gills closely beset with cylindrical cells swollen at the base, length: c. 50 μ, breadth above: 6—7 μ, below: c. 10 μ.

555. **N. sobria** Fries (?), Hym. Eur., p. 263.

On naked ground in deep cracks at Glerá (Akureyri) and on the sides of turf-pits at Seyðisfjörður [P. L.].

Pileus 1—2.5 cm broad, campanulate with incurved margin, then almost plane with slightly raised centre, not hygrophanous, pale brown or alutaceous (k 2), reddish-brown in the centre (h 2), silky, fibrous, or sprinkled with bran on the surface. — Stipe cylindrical, base somewhat

dilated, hollow, curved, 3—4 cm long, 2—2.5 mm thick, pale above and covered with the floccose remains of the veil, brown below. — Gills crowded, broadly adnate, edge of gills crenulate and fimbrillate, clay-coloured (k 2). — Spores brown, smooth, ellipsoidal, with an oblique apiculus below, 9—10 × 5 μ. — Edge of gills beset with sterile cylindrical cells, 6—8 μ broad.

556. **N. sp.**

Laxárdalur near Mývatn [P. L.]. — Among moss in sandy meadows.

Pileus 10—16 mm broad, at first convex, margin incurved with a white fibrous veil, hygrophanous, pellucidly striate at margin, then plane or somewhat depressed, sometimes umbonate, chestnut-coloured when moist (between h 1 and h 2), tawny when dry (e 3), the margin of the cap sometimes crenulate and showing remains of the white veil. — The stipe terete, hollow, concolorous, cylindrical or slightly dilated at base and clothed with white hyphæ, densely pubescent above with projecting short hyphæ. — Gills slightly ventricose, rounded adnate, edge denticulate, darker brown than the face which has the colour g 2. — Spores ovoid, pale yellowish brown, punctate, 8—11 × 5.5—6.4 μ. — Edge of gills and upper part of stipe beset with 50 μ long, conical cystidia, 3—4 μ broad above, and c. 10 μ broad below, at length with tawny contents.

Galera Fries.

557. **G. tenera** (Schaeffer) Fries.

Agaricus tener Schaeffer, Fung. Ic., t. 70, f. 6—8.

Seyðisfjörður, Akureyri [P. L.].

Pileus 1—3 cm broad, conico-campanulate, hygrophanous, margin pellucidly striate, tawny in the fresh and moist state (k 6), paler when dry. Flesh concolorous, thin skin-like, brittle. — Stipe cylindrical, base bulbous, minutely striate-sulcate, hollow, rigid, brittle, pale above, rusty below. — Gills tawny (g 3), ascending, narrow, crowded, adnate. — Spores brown, smooth, ellipsoidal, germ pore distinct, 12— × 6—6.5 μ. — Cystidia at edge of gills flask-shaped with a spherical head, 5 μ in diameter, with a 2 μ long pedicel.

558. **G. sp.**

Hallormstaðir, Akureyri [P. L.]. — Littoral fields and farm-yards. Grows directly on cow-dung.

Pileus 1—1.5 cm broad, hemispherical, with thin flesh, hygrophanous, margin pellucidly striate, viscid and brown when moist (e 3), somewhat shining and almost white when dry (e 5). — Stipe short (2—2.5 cm long, 1—2 mm thick), slightly swollen at base and as a rule curved, striate above, everywhere mealy and floccose. — Gills at first pale, almost white, then tawny with a red tinge (l 6), broad at the margin of cap, rounded towards the stipe, narrowly adnate, edge white and fimbrillate. — Spores ellipsoidal, smooth, with a distinct germ pore, yellow, 12—13 × 6—6.5 μ.

— Cystidia at the edge of gills flask-shaped, with a short, thin stalk below, neck $10 \times 4-5\ \mu$, head $5-6\ \mu$ in diameter.

Note. Cannot be referred to any species described in the literature, but as the treatment of the Galera species by the different anthors is very uncertain and dissimilar, it is difficult to give any grounds for the establishment of a new species in this genus.

559. **G. siliginea** Fries, Obs. Myc. II, p. 168.

Isafjörður [Gandrup], Akureyri [P. L.]. —. On peaty soil.

Pileus 1—2 cm broad, at first vaulted, then expanded with a somewhat irregularly undulate and sometimes reflexed margin about a low obtuse umbo: the whole pileus grey. — Gills adnate, moderately crowded, ochre-brown. — Stipe cylindrical, somewhat undulate, pale, slightly dilated at base. — Spores tawny, ellipsoidal, with a germ pore, $10-12 \times 5-5.5\ \mu$. — Cystidia flask-shaped with a long neck and spherical head.

560. **G. hypnorum** (Schrank) Fries, Syst. Myc. I, p. 267.

Lambadalur near Dýrafjörður [C. H. O.], det. E. Rostrup.

561. **G. mycenopsis** Fries, Obs. Myc. II, p. 38, no. 28.

This species is very common and occurs among moss and grass in bogs, swamps, and wet tuffs [P. L.].

Pileus 1—2 cm broad, hemispherical, then expanded but always with a raised centre, skin-like, with thin flesh, hygrophanous, pellucidly striate, when moist, the colour is c 3, in the dry state b 7, the margin in young specimens has a pendent white fibrillose veil. — Stipe subconical, 1—2 mm thick above, 2—3 mm below, 4—6 cm long, covered with a silky white coating, below which it is coloured like the cap. — Gills distant, adnate. Edge of gills rather thick and somewhat fimbrillate. Colour of gills b 6. — Spores ellipsoidal, smooth, yellow, germ pore absent, length very variable, viz. $10-15 \times 6-7\ \mu$. Cystidia at edge of gills rather variable in shape, but mostly elongate-flaskshaped with a swollen apex, $45-50\ \mu$ long, the greatest breadth near the base being c. $10\ \mu$, the head up to $8\ \mu$ in diameter.

Crepidotus Fries.

562. **C. citrinus** n. sp.

On the island of Slutnes in Mývatn [P. L.]. — Grows on dead branches of Salix phylicifolia lying on damp ground.

Pileus 5—8 mm broad, resupinate, excentrically attached by the upper side of the pileus, citron-yellow (l 3), with dense but short hairs on the raised and somewhat incurved margin. — Gills crowded,

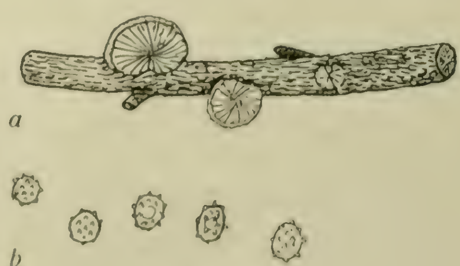


Fig. 19.

Crepidotus citrinus n. sp.
a. Group of fungi, nat. size.
b. Spores $\times$ 750.

at first coloured like the cap, then more tawny, edge dentate. — Basidia clavate, 4-spored. — Spores tawny, spherical or broadly ellipsoidal, echinulate, the smallest $5 \times 5\ \mu$, the mediumsized $6.5 \times 5-6\ \mu$ and the largest $7.5 \times 5.5-6\ \mu$. — No cystidia.

Allied to *C. nidulans* (Pers.) Quélet, yet easy to distinguish both macro- and microscopically.

Psalliota Fries.

563. **P. campestris** (Linné) sensu J. E. Lange, Dansk Botanisk Arkiv, vol. 4, No. 12, p. 9.

Vallanes in Lagerfljót [P. L.]. — In manured homefields.

Cap at first hemispherical with incurved margin, then expanded, convex with straight margin, flesh thick, reddening faintly when broken, surface silky and white. — Stipe subcylindrical, stuffed, surface like that of the cap, bearing an evanescent ring splitting up into hairs. — Gills free, at first pale, then red, at length dark brown. — Spores somewhat irregularly ovoid, smooth, purple brown, $6.5-8 \times 4.5-5\ \mu$.

Note. Several other localities have been recorded by collectors, though it has not been possible to ascertain what they meant by *P. campestris*, viz. Grimsey [O. D.], heaths by Grjótnes and Akureyri [C. H. O.], Möðruvellir [St. St.], Vallanes [Helgi Jónsson].

564. **P. Elvensis** Berkeley et Broome var. **alba** n. var.

By Laxá south-west of Mývatn [P. L.]. — On mounds of earth round sheepfolds.

Pileus 7—14 cm broad, campanulate with incurved margin, white or dingy white, cuticle thick, splitting up into patches ending with deflexed and upward curving points, flesh thick, white, reddening faintly when bruised, with a yellow tinge below the cuticle. — Stipe subcylindrical but with the base attenuated, fistulose, filled below with a felty pith; flesh of stipe like that of cap, but citron-yellow in the lower part. Ring raised, skin-like, single. — Gills at first pale, then incarnate (m 3), finally dark reddish brown (c 3), up to 12 mm broad, crowded, rounded towards the stipe, free. — Basidia 4-spored. — Spores spherical or broadly ellipsoidal, the spherical spores are $6\ \mu$ in diameter, the ellipsoidal ones $7-7.5 \times 6\ \mu$. Differing especially in the colour of the pileus.

565. **P. arvensis** (Schaeffer) sensu Ricken.

Agaricus arvensis Schaeffer, Fung. Ic., t. 310 and 311.

Reykjahlíð near Mývatn [P. L.]. — Under scattered birches on lava fields.

Pileus 7—10 cm broad, convex, then plano-convex, silkyhaired or squamulose, white to whitish yellow; flesh white, assumes a yellow tinge when bruised. — Stipe cylindrical, bulbous, hollow, white, at length becoming sooty, bearing a double ring, the lower layer radiately rimose. — Gills at first almost white, becoming greyish red and finally almost black, broadest in front, free. Basidia 4-spored. — Spores ellipsoidal, smooth, purple brown, $7-7.5 \times 4-4.5\ \mu$.

Stropharia Fries.

566. **S. semiglobata** (Batsch) Fries, Hym. Eur., p. 287.

Agaricus semiglobatus Batsch, Elenchus fungorum, cont. I, 1786, p. 141.

Möðrudalur, Isafjörður, Þingvellir [P. L.]. — On cow-dung and horse-dung.

Pileus 2—3 cm broad, hemispherical, pale yellow (1 4), slimy. — Stipe cylindrical, 3—7 cm tall, 2 mm thick, concolorous — paler at apex — slimy, with a membranaceous slimy ring. — Gills broad, distant, broadly adnate, grey, then almost black, margin plane. — Spores ovoid, germ pore distinct, at first violet, then brown, 15—17×8—9 μ. — Cystidia at edge of gills cylindrically hairshaped with swollen apex.

567. **S. coronilla** (Bulliard) Fries, Syst. Myc. I, p. 282.

Agaricus coronillus Bulliard, Hist. champ., t. 597.

Iceland's Horticultural Experimental Station at Akureyri [P. L.]. — Among grass under birches.

Pileus 3—4 cm broad, convex, viscid, yellow (1 3—1 4), flesh thick, firm and white. — Stipe cylindrical or somewhat dilated above, white, sulcate above, bearing a white ring, sulcate on the upper face. — Gills broad, somewhat ventricose, rounded towards the stipe, narrowly adnate with a decurrent tooth, at first greyish white, then purple-violet (a 5), edge dentate. — Spores ovoid with a germ pore, brown under the microscope, 9.5—10×5.5 μ. — Cystidia at edge of gills cylindrical with a head-like swelling at the apex.

Annellaria Karsten.

568. **A. separata** (Linné) Karsten, Hattsvampar I, p. 517.

Agaricus separatus Linné, Flora Suecica, No. 1220.

Möðruvellir [St. St.], Dýrafjörður and Þingeyri [C. H. O.], Staðarhraun [Feddersen], Laugarnes [P. L.]. — On dung, especially cow-dung.

Pileus 3—4 cm broad and high, campanulate, the viscid surface pale greyish yellow when fresh (k 4) in the dry state k 1. — Stipe erect, elongate-conical, rigid, pale, with a white raised ring above the middle, sulcate above the ring, below the ring slimy. — Gills ascending, adnate, dark brown with lighter spots, then black with a white margin. — Spore-powder black. Spores blackish brown, lemon-shaped, 15—20×9—11 μ.

Note. On the remains of a manure heap at Laugarnes from 100 to 200 fungi occurred within an area of 6 m^2. They were unusually large, the cap up to 12 cm broad and stipe 20 cm long and 1.5 cm broad below.

Panaeolus Fries.

569. **P. papilionaceus** (Bulliard) Fries, Epicr., p. 236.

Agaricus papilionaceus Bulliard, l. c., t. 561, f. 2.

Mývatn, Glerá near Akureyri [P. L.]. — On horse-dung in meadows near Glerá and Mývatn.

Pileus c. 3 cm broad, at first hemispherical, then expanded, fleshy, not hygrophanous, greyish-red (d 8), pitted, at length with cracked cuticle. — Stipe concolorous, darker below, farinaceous above. — Gills broad, adnate, black with white spots, margin white-fringed. — Spores black, almond-shaped, 16—17 × 11 μ. — Cystidia at the edge of gills at apex clavate, swollen, up to 7.5 μ broad.

The cystidia differ decidedly from those of *P. campanulatus*.

570. **P. campanulatus** (Linné) Fries, Hym. Eur., p. 311.

Agaricus panulatus Linné, Flora Suecica 2, No. 1213.

Reykjavík (Feddersen and C. H. O.), det. E. Rostrup.

571. **P. fimicola** Fries, Syst. Myc. I, p. 301.

Reykjahlíd, Skútustaðir, Laxádalur, Reykjadalur, Ljósavatn and Elliðavatn [P. L.]. — In homefields.

Pileus 1—4 cm broad, at first campanulate, then expanded, hygrophanous, veil none, dark olive-brown (c 3) when moist, light reddish-brown when dry (between g 2 and d 7), but long retaining a dark marginal zone. — Stipe 4—7 cm long, 2—3 mm thick, fragile, hollow, brown below, pale and farinaceous above. — Gills crowded, ventricose, adnate, variegated, with white margin, at length black. — Spores ellipsoidal or somewhat almond-shaped, dark brown, smooth, 12—13×7—7.5 μ. — Cystidia at edge of gills cylindrical, somewhat dilated at base.

Psilocybe Fries.

572. **P. ericaea** (Persoon) Fries.

Agaricus ericaeus Persoon, Synops. meth. fung., p. 413.

Found at Reykholt by Robert and recorded in E. Rostrup's Isl. Svampe 1903, p. 296.

573. **P. atrorufa** (Schaeffer) Fries, Syst. Myc. I, p. 293.

Agaricus atrorufus Schaeffer, Fung. Ic., t. 234.

Þingvellir and Mývatn [P. L.]. — Among grass in damp homefields.

Pileus 1—1.5 cm broad, convex, hygrophanous, not slimy, margin striate; dark reddish-brown (j 5), when moist, pallid when dry (g 4). — Stipe 3—4 cm long, 1—2 mm thick, pale and mealy above, dark brown below, adpresso-fibrillose, cartilaginous, hollow. — Gills brown, broadly adnate and slightly decurrent, crowded. — Spores ellipsoidal, brown, 8×4.5 μ. — Cystidia at the edge of gills spindle-shaped, acute.

574. **P. physaloides** (Bulliard) Fries, Hym. Eur., p. 300.

Agaricus physaloides Bulliard, Hist. champ., t. 366, f. 1.

Seyðisfjörður [P. L.]. — Outfields and bogs.

Pileus 1—2 cm broad, campanulate, umbonate, depressed about the umbo, with thin flesh, reddish-brown (h 2); margin pellucidly striate. — Stipe short (3 cm long, 1—2 mm thick), hollow, flexuose, concolorous below, paler and mealy above, with a thin coating of adpressed hairs. — Gills at first pale, then concolorous, broadly adnate. — Spores ellipsoidal, smooth, brown, 8—10×5—5.5 μ. — Cystidia at the edge of gills cylindric.

575. **P. bullacea** (Bulliard) Fries, Syst. Myc. I, p. 297.

Agaricus bullaceus Bulliard, Hist. champ., t. 566, f. 3.

Hallormstaðir [P. L.]. — Among moss in bogs.

Pileus up to 2 cm broad, hemispherical, hygrophanous, striate, dark with brownish or reddish tinge (c 2)', when dry k 2 to k 3, with well-developed veil at margin. — Stipe cylindrical, 3 cm high, 2 mm thick, hollow, brown, covered with white scurf sometimes forming a distinct ring. — Gills broad, broadly adnate, purple-brown, edge white, dentate. — Spores ovoid with truncate apex, purple-brown, 7×4.5—5 μ. — Cystidia at the edge of gills flexuose, hairshaped with swollen base.

576. **P. merdaria** (Fries) Ricken.

Stropharia merdaria Fries, Hym. Eur., p. 286.

Isafjörður and Tjörnin (Reykjavík) [P. L.]. — In homefields.

Pileus 1.5—2 cm broad, at first hemispherical, then plano-convex, olive-brown (h 4 to h 8), epidermal layer viscid, margin striate, distinct marginal veil in young specimens. — Stipe 2—4 cm high, 2—3 mm thick, more or less swollen at base, hollow, concolorous, but with a frayed, greyish-white coating, mealy above. — Gills broad, broadly adnate, at first grey then purple brown with a white fringed edge. — Spores smooth, ellipsoidal with a germ pore, purple violet at length brown, 12—14×8—9 μ. — Cystidia at edge of gills conical or flexuose spindle shaped, strongly acuminate.

577. **P. elongata** (Persoon) Fries.

Agaricus elongatus Persoon, Icones et descriptiones fungorum, t. 1, f. 4.

Vallanes in Lagarfljót, Grund near Akureyri [P. L.]. — Among Sphagnum in bogs.

Pileus 1—2 cm broad, plano-convex, ± umbonate, pale yellowish-white becoming olive yellow (o 5), centre as a rule pale reddish-brown (h 3), somewhat hygrophanous and with pellucidly striate margin. — Flesh pale, taste bitter. — Stipe cylindrical, flexuose, tough, 6—8 cm high, 1—2 mm thick, pale yellow above, the remains of the veil forming an imperfect ring, reddish brown externally and internally below, shining when dry. — Gills at first nearly white, then purple-grey, broadly adnate or slightly emarginate, edge of gills denticulate under the lens. — Spores ovoid, pale purple, 9—12×5.5—6.5 μ (some few spores up to 14×7.5 μ). — Cystidia at the edge of gills (really the ends of hyphae from the trama) spindleshaped with slightly swollen apex, 35×6—8 μ, colourless

The face of the gills bears true cystidia, these are fusiform, 50—10 μ, with yellow granular contents.

Psathyra Fries.

578. **P. spadiceo-grisea** (Schaeffer) Fries, Hym. Eur., p. 306.

Lagarfljót, Reykjahlíd and Norðtúnga [P. L.]. — In copses of Betula pubescens and Betula nana.

Pileus 3—4 cm broad, convex, ± gibbous, with striate-sulcate margin, flesh thin and brittle, hygrophanous, reddish-hrown when moist (j 3), fuscous when dry (k 4). — Stipe shiny white, rigid, flexuose, fragile, hollow, distantly and slightly floccose above. — Gills narrow, crowded, broadly adnate, pale greyish-brown, then black with white frayed edge. — Spores dark-brown, 8—9×5 μ, sometimes faintly curved. — Cystidia short, cylindrical, swollen in the middle, 30—40×10 μ.

579. **P. gossypina** (Bulliard) Fries, Syst. Myc. I, p. 310.

Agaricus gossypinus Bulliard, l. c., t. 425. f. 2.

Hallormstaðir [P. L.]. — On the ground among twigs and branches in birch copses.

Pileus 2—4 cm broad, convex, gibbous with pellucidly striate margin, brown (h 2) when moist, grey (h 4) when dry, the remains of the white veil hanging from the margin. — Stipe cylindrical, shining, white, covered with a white frayed coating, hollow, brittle. — Gills ventricose, broadly adnate, crowded, at first grey then dark-brown. — Spores brown, ellipsoidal, 8—9×4—4.5 μ. — Cystidia fusiform, drawn out above into a short point.

580. **P. bifrons** (Berkeley) Fries, Monographia Hym. II, p. 347.

Agaricus bifrons Berkeley, English Flora V, p. 114.

Hallormstaðir [P. L.]. — Under willows in bogs.

Pileus up to 3 cm broad, obtusely conico-campanulate, flesh thin or skin-like, rugose and pitted at the margin, which is at first covered by a thin fugaceous veil, hygrophanous, reddish-brown (j 3) when moist, alutaceous (k 1 to j 1) when dry. — Stipe cylindrical-conical, rigid, brittle, hollow, white, mealy and floccose above, covered with projecting hairs at base. — Gills ascending, adnate, pale grey, then dark-brown, but white at the edge. — Spores ellipsoidal, smooth, dark-brown, 13×7 μ. — Cystidia elongate-conical with obtuse apex, 40—50 μ long.

Psathyrella Fries.

581. **P. prona** Fries, Hym. Eur., p. 315.

Agaricus pronus Berkeley et Broome, No. 924.

Reykjavík [P. L.]. — Roadside by Elliðaá.

Pileus 1—1.5 cm broad, hemispherical, flesh thin, margin striate, sericeo-pulverulent, brown (h 3) when moist, livid (e 2) when dry. —

Stipe 4 cm high, 1 mm thick, white, flexuose, hollow, mealy at apex, base often dilated. — Gills grey, then dark with light edges, ventricose, adnate. — Spores black, ellipsoidal, smooth, $13—16 \times 7—8.5\ \mu$. — Cystidia hairshaped with swollen base.

582. **P. arata** Berkeley, Outlines of Br. Fungology, p. 176.

Akureyri [C. O. H.], det. E. Rostrup. — On moist sandy soil near Glerá.

Rostrup's name *P. atrata* is incorrect, perhaps a misprint.

Lactariaceae.

Lactarius Fries.

583. **L. tabidus** Fries, Epicr., p. 346.

Hallormstaðir [P. L.]. — Under birches and willows.

Milk white, somewhat pungent. Pileus c. 2 cm broad, plano-convex, slightly umbonate, sometimes uneven, rugulose, margin thin, pellucidly striate, when moist reddish brown (j 2), paler when dry. — Stipe cylindrical, slightly dilated at base, reddish-brown, often slightly mealy. — Gills rather distant, adnate, pale incarnate (e 7). — Spores white, echinate, almost spherical $8—9 \times 7—8\ \mu$.

584. **L. glyciosmus** Fries, Epicr., p. 348.

Hallormstaðir, Eyjafjörður [P. L.]. — On the shore at Glerá and in birch copses.

Milk white or watery, sparse. — Pileus c. 5 cm broad, plano-convex, more or less depressed in the centre, with an acute or rounded umbo. Margin incurved, violet-grey (a 5), surface f 8—g 7. — Stipe cylindrical, pale reddish yellow (k 4), covered with a greyish-white mealy coating. — Gills at first white, then pale reddish yellow (k 1—k 3), broadly adnate or somewhat decurrent, not branched. — Spores faintly yellow, echinate-verrucose, somewhat angular, $8—8.5 \times 7\ \mu$. Flesh pale reddish yellow (k 2), smells like cinnamon.

585. **L. lilacinus** (Lasch) Fries, Hym. Eur., p. 435.

Agaricus lilacinus Lasch, Linnaea III, No. 78.

Egilsstaðir [P. L.]. — In birch copses, meadows and bogs.

Milk white, acrid. — Pileus 4—7 cm broad, plano-convex, then depressed in the centre about a small umbo, at first slightly tomentose, then rimose and almost squamose, lilac-incarnate (n 7), turning brown-violet (j 3). Flesh of cap tinged with red. — Stipe cylindrical, reddish yellow to ochre (k 3), apex mealy. — Gills coloured like the cap, somewhat decurrent. — Spores with a yellowish tinge, subspherical, echinate, $7.5—8.5\ \mu$.

586. **L. uvidus** Fries, Epicr., p. 338.

Eyjólfsstaðir [P. L.]. — In birch copses.

Milk acrid, turns violet like the flesh. — Pileus 3—7 cm broad

convex, then depressed in the centre, margin involute, naked, slimy, greyish violet (o 3—o 4). — Flesh white, but turning violet when wounded (n 4—o 6). — Stipe slimy, pitted, greyish yellow (k 2), turns violet when wounded. — Gills white to yellowish (k 1), becoming violet on contact, broadly adnate or somewhat decurrent, crowded. — Spores pale, verrucose, 10×8—9 μ.

587. **L. uvidus** Fries var. **farinipes** n. var.

This variety agrees in all essentials with the main species, but differs from it in the stipe never being slimy, but always covered with a grey or greyish red mealy coating.

It is far more frequent in Iceland than the main species and occurs in meadows, bogs, and on knolls in moist spots of the mountain pastures.

Lagarfljót (both at Hallormstaðir, Vallanes, Eyjólfsstaðir and Egilsstaðir), Jökúlsá á Bru [P. L.].

588. **L. torminosus** (Schaeffer) Fries, Epicr., p. 334.

Agaricus torminosus Schaeffer, Fung. Ic., t. 12.

Lagarfljót, Mývatn [P. L.]. — Common in copses of Betula pubescens and Betula nana.

Milk white, acrid. — Pileus 6—8 cm broad, convex, then strongly depressed, viscid, tomentose-squarrose, especially along the incurved bearded margin, pale incarnate (e 5), with more brightly coloured (c 8) zones. — Stipe cylindrical, hollow, pale incarnate (e 5). — Gills pale yellow (b 7), crowded, decurrent. — Spores white, subspherical, echinate, 8—9×9 μ.

Russula Fries.

589. **R. delica** Fries sensu Bresadola, Fungi tridentini, t. 201.

Lagarfljót. — Fairly common in birch copses.

Pileus 6—10 cm broad, convex with depressed centre, at length infundibuliform, margin incurved, not sulcate. Pellicle of pileus but slightly developed, at length split into small patches, colour white with a brownish tinge (g 5). — Flesh white, slightly bitter. — Stipe short, becoming thinner, slightly tomentose, concolorous. — Gills white to creamcolour (never shaded with green), crowded, narrow, forked at margin of cap. — Spores white, subspherical, echinulate, 8—10×8 μ.

Note. The fact that apparently there only occurs in Iceland the form with white or faintly yellowish gills would seem to indicate that *Russula chloroides* (Krombh.) Br. is a distinct species and should not be referred to *Russula delica*.

590. **R. graminicolor** (Secretan) Quélet.

Agaricus graminicolor Secretan, Mycographie Suisse I, No. 518.

Here and there in the birch copse in the Lagarfljót Valley [P. L.].

Pileus 5—6 cm broad, plano-convex with depressed centre, margin

rounded, at length sulcate, pellicle well developed, separable, somewhat slimy, dark-green in the centre (f 5), somewhat paler at the margin (i 7). Flesh white, palatable. — Stipe subcylindrical or attenuated at the base, white with low ridges and veins, at length with brown spots. — Gills cream-coloured, emarginate-adnate, edge denticulate. — Spore powder cream-coloured, spores echinulate, oblong, 7—8×6 μ.

591. **R. lilacea** Quélet, Flore myc. de la Fr., p. 348.

Common in birch copses everywhere in the Lagarfljót Valley [P. L.].

Pileus 3—5 cm broad, plano-convex, centre depressed, slimy and viscid when moist, dark reddish-violet (from n 1 to n 3) in the centre, paler towards the margin (n 7), margin at length slightly sulcate. Flesh comparatively thick, white, taste mild. — Stipe cylindrical or dilated below, shaded with red in the middle, sometimes the whole stipe is red (m 4). — Gills emarginate, crowded, at first pure white, then pale, partly forked. — Spore powder almost white. Spores white, broadly ellipsoidal, 7—8×6 μ.

592. **R. vinosa** Quélet, Flore myc. de la Fr., p. 348.

In birch copses and among grass both in the valleys and in mountain pastures. Common in the west-, north- and east-country [P. L.].

Pileus 4—6 cm broad, plano-convex, at length with depressed centre, slimy, viscid, margin at length sulcate. Dark red in the centre (d 1), margin vinous red (d 4). Flesh white, but red below the pellicle, turning grey and soft, taste mild. — Stipe cylindrical, with a somewhat dilated but acuminate base, white, mealy and sulcate, firm, but becoming grey and soft. — Gills white with a yellowish tinge, becoming grey, equal, branched at the stipe, brittle, adnate. — Spore powder pale. Spores white, echinulate, 8—9×7—8 μ. — Cystidia at the edge of the gills lanceolate, apex pointed, contents granular.

Note. Though this Russula is very similar to *R. depallens* (Pers.) Fries, still it differs so much from it in several respects that it must be considered correct to regard it as a distinct species. Among the differences I may point out its geographical distribution, which does not coincide with that of *R. depallens*. Thus the latter species or form has not been observed in Iceland.

593. **R. grisea** (Persoon) Bresadola, Iconographia mycologica, Tab. 452.

Hallormstaðir [P. L.]. — In birch copses.

Pileus 7—8 cm broad, convex, centre depressed, margin at length sulcate, well developed with a thin pellicle, viscid and slimy when moist, resembling in colour *R. cyanoxantha*, changing between olive-green, purple, and ochre. Flesh white, but with a lilac tinge below the pellicle, taste mild. — Stipe almost equal, though sometimes dilated at base, white, finely rugose-sulcate. — Gills broadest in front, narrowly adnate, forked at the stipe, at first cream-coloured, then yellow. Spore powder yellow. — Spores pale yellow, echinulate, subspherical, 7—7.5 μ in diameter.

594. **R. ochracea** (Albertini et Schweinitz) Fries, Epicr. I, p. 362.

Hallormstaðir [P. L.]. — In birch copses. Fairly common.

Pileus 5—8 cm broad, plano-convex, centre depressed, margin thin, sulcate. Pellicle slimy and viscid (often covered with earth), margin pale ochre (k 2), centre darker, brownish (h 3 to g 7). Flesh ochraceous (k 2), taste mild. — Stipe white with a brownish tinge, sulcate above, rather short and thick. — Gills narrowly adnate or somewhat emarginate and then with a decurrent tooth, yellow with a yellowish-red tinge (b 7). — Spore powder yellow. Spores yellow, echinulate, subspherical, very variable in size, 7—9 μ in diameter.

595. **R. decolorans** Fries, Epicr., p. 361.

Egilsstaðir and Seyðisfjörður [P. L.]. — In birch copses. Not common.

Pileus c. 8 cm broad, at first subspherical, then plano-convex, margin very long even, at length somewhat sulcate, pellicle slimy; when fresh it has two main colours: blood-red (j 6—j 7) and orange-yellow (b 5), but soon becoming discoloured to a pale alutaceous (k 2) with a reddish tinge left especially at the margin. Flesh of cap hard, pale, becoming fuscous, taste mild. — Stipe short and thick (4—6 cm × 2—4 cm), base swollen, surface conspicuously veined, at first white, then fuscous with rusty brown spots, especially below. Flesh of stipe soft. — Gills at first pale (g 5), then with a reddish-yellow tinge and finally spotted with rusty brown, especially at the edge of gills. — Spore powder yellow. Spores pale yellow, subspherical or oval, echinulate-verrucose, of rather variable size, 9—11 μ in diameter, some few even larger.

596. **R. nauseosa** (Persoon) Fries, Epicrisis, p. 363.

Agaricus nauseosus Persoon, Synops. meth. fung., No. 446.

Hallormstaðir [P. L.]. — In birch copses. Not common.

Pileus 3—5 cm broad, plano-convex, at length almost infundibuliform, flesh thin; slimy, margin at first even, finally sulcate-tuberculate, colour dingy purple (n 8), but the centre may be olive (i 7) or fuscous (h 4), while the margin is grey to purple and more or less covered with yellow spots. — Flesh soft, brittle, white, smell unpleasant, taste at first mild, then acrid. — Stipe equal, white, spongy-brittle, spotted with brown on contact, at length becoming grey. — Gills at first pale, then yellow, some few forked, rounded towards the stipe. — Spore powder yellow. Spores pale yellow, echinulate, subspherical, 8—9 μ in diameter.

597. **R. fragilis** (Persoon) Fries?, E. Rostrup, Isl. Svampe 1903, p. 296.

Holar in N. Iceland (Grønlund), det. E. Rostrup.

Note. The present writer considers it doubtful whether the determination of this species is correct. I have not observed it anywhere in the birch copses, though this should be the locality where one might expect to find this species.

598. **R. Queletii** Fries, in Quélet: Les Champ. du Jura, p. 185, t. 24, f. 6.

Hallormstaðir [P. L.]. — On grassy spots in birch copses. Not rare.

Pileus 5—7 cm broad, plano-convex, margin thin, at length sulcate, pellicle scarcely viscid, mealy, purple-violet (d 1), centre almost black (c. 3). — Flesh white, but purple beneath the separable pellicle, at first fairly firm, then soft, odour none, taste acrid. — Stipe cylindrical, pale purplish red (m 4), mealy. — Gills pale, becoming greyish white, exuding drops from the edge of gills when fresh. — Spore powder greyish white, spores white, subspherical, echinulate 8—9×7—8 μ.

Coprinariaceae.

Coprinus (Persoon) Fries.

599. **C. velox** Godey, in Gillet's Les champignons de la France, Hyménomycètes, t. 175.

Seyðisfjörður, Norðtúnga [P. L.]. — On horsedung and cowdung.

Pileus 4 mm broad, skin-like, margin sulcate, centre squamulose or scurfy, grey. — Stipe 2 cm long, $^1/_2$ mm thick, white, base hairy. — Gills grey, thin, reaching the stem. — Spores ellipsoidal, brown, 8—9×5 μ.

600. **C. ephemerus** (Bulliard) Fries, Epicr., p. 252.

Agaricus ephemerus Bulliard, Hist. champ., t. 128.

Reykjavík and Seyðisfjörður [P. L.]. — On horsedung and cowdung.

Pileus 1—1.5 cm broad, at first ovoid, then expanded with split raised margin, skin-like, covered with scattered short hairs, greyish yellow with a brownish centre. — Stipe 3—5 cm long, 1—1.5 mm thick, hollow, whitish grey, mealy, base hairy. — Spores dark-brown, ellipsoidal, 10—13×7 μ.

601. **C. tigrinellus** Boudier, Icones mycologicae, t. 139.

On stems and leaves of dead and living species of Carex in wet bogs about Þingvallavatn [P. L.].

Pileus at first ovoid with somewhat pointed summit, 1 cm high and broad, then expanded with revolute split margin, white, but covered in spots with a dark-grey, mealy layer. — Stipe white, smooth, pellucid, swollen and floccose at base. — Gills at first white, then dark 2—3 mm broad, free. — Spores dark-brown, broadly ellipsoidal, 11—15×7—9 μ.

602. **C. cordisporus** Gibbs, in J. E. Lange, Dansk Bot. Ark., Bind 2, No. 3, 1915, p. 43, pl. I, fig. g.

Seyðisfjörður and Reykjavík [P. L.]. — On horsedung in bogs.

Pileus cylindrical, then flat and radiately striate-plicate, skin-like, 6—8 mm broad, pale with a yellow centre, covered by a mealy layer consisting of spherical cells, 20—40 μ in diameter. — Stipe 2—3 cm long,

1 mm thick, white, smooth, clothed with projecting hairs below. — Gills at first pale, then black, narrow, distant, free. — Spores dark purplish-brown, flattened, heartshaped on a side view, c. 9 μ in diameter, viewed from the edge ellipsoidal and 9×6 μ.

603. **C. ephemeroides** (Bulliard) Fries, Epicr., p. 250.

Hofsfjall [O. D.]. — On horsedung.

The present writer has not observed this species in Iceland, but it is given by E. Rostrup in Isl. Svampe 1903, p. 296.

604. **C. fimetarius** (Linné) Fries, Epicr., p. 245.

Agaricus fimetarius Linné, Flora Suecica, No. 1213.

Akureyri [P. L.]. — On highly manured littoral field.

Pileus at first clavate, then broadly conical with raised sulcate margin, 2—5 cm high and broad, grey, brownish in centre, covered by a floccose-squamulose layer. — Stipe elongate conical with a peronate-floccose base, white, hollow, very fragile. — Gills at first grey, then black, free, soon deliquescent as well as the whole cap. — Spores blackish brown, ellipsoidal, $12—14.5 \times 7—8$ μ.

605. **C. atramentarius** (Bulliard) Fries, Epicr., p. 243.

Agaricus atramentarius Bulliard, l. c., t. 164.

Máfahlíð (Helgi Jónsson).

This species is listed among Iceland's fungi by E. Rostrup, Isl. Svampe 1903, p. 296.

Boletaceae.

Suillus Micheli.

606. **S. castaneus** (Bulliard) Karsten.

Boletus castaneus Bulliard, l. c., t. 328.

Grjótnes [C. H. O.], det. E. Rostrup. — On a heath.

Boletus Dillenius.

607. **B. scaber** Bulliard, l. c., t. 489, f. 1.

Common in birch copses throughout Iceland [P. L.].

608. **B. laevis** Fries, Epicr., p. 425.

Note. E. Fries states in the Epicrisis that he received this Boletus from Count Raben, who had collected it in Iceland. The species has been diagnosed on the basis of material preserved in alcohol. *B. laevis* has never been found again either in Iceland or elsewhere, and since the diagnosis of Fries renders it quite permissible to regard *B. laevis* as an accidental smoothly stipitate variant of *B. scaber*, there seems to be no reason to maintain *B. laevis* as a species.

609. **B. bovinus** Linné, Flora Suecica, No. 1246(?).

Stated by E. Rostrup in Isl. Svampe 1903 p. 295 to have been found in Iceland by König.

Note. It must be regarded as doubtful whether this pronounced inhabitant of coniferous woods occurred in Iceland at a time when there were no coniferous trees at all in the island.

610. **B. piperatus** Bulliard, l. c., t. 451, f. 2.

Egilsstaðir [P. L.]. — Among moss in birch copses.

Pileus 4—5 cm broad, flatly vaulted, viscid, tawny (g 2), flesh thin, yellowish, taste burning. — Tubes tawny (g 2), adnate to the stipe, somewhat decurrent; mouths large, edged with the colour l 7. — Stipe cylindrical, stuffed, 5—6 cm long, 6—8 mm thick, coloured like the cap, but the base citron-yellow (b 4). — Spores smooth, tawny, narrowly ellipsoidal, 8—9×3.5—4 μ.

Boletopsis P. Hennings.

611. **B. luteus** (Linné) P. Hennings.

Boletus luteus Linné, Flora suecica, No. 1247.

Hallormstaðir [P. L.]. — Under several Pinus montana, c. 15-year-old, grown from seed imported from Norway in a plantation, in a birch copse.

The finding of *B. luteus* by Björn Halldórsson, recorded by E. Rostrup in Botanisk Tidsskrift, Isl. Svampe 1903, p. 295, must undoubtedly be due to an error on the part of Björn Halldórsson, since Iceland was then without coniferous trees.

Lycoperdaceae.

Bovista Persoon.

612. **B. nigrescens** Persoon.

Lycoperdon nigrescens Vittadini, Monographia Lycoperdineorum, p. 176.

Grímsey, Spónsgerði, Hof, Hlöð in Hörgardalur, Arnarnes, Hraun in Fljót [O. D.]; Möðruvellir [St. St.]; Silfrastaðir, Skagafjörður [Thoroddsen]; Dýrafjörður [C. O. H.]; Vestmannaeyjar [St. St.].

613. **B. plumbea** Persoon.

Lycoperdon plumbeum Vittadini, Monographia Lycoperdineorum, p. 174.

Stórá Brekka [O. D.]; Dýrafjörður [C. O. H.]; in farm yards in Skútustaðir near Mývatn [P. L.].

614. **B. clavata** Fries, Syst, Myc. III, p. 23.

The species was established on the basis of some specimens brought

home by Thienemann from a journey in Iceland and has never been found again since.

Lycoperdon Tournefort.

615. **L. bovista** Linné, Species plantarum, p. 1653.

Möðruvellir [Thoroddsen]; Hofsfjall, Gásir [O. D.]; Búðir, Vallanes [H. J.]. — Stated by Mohr and Robert to be common in Iceland.

616. **L. pusillum** (Batsch) Persoon.

Lloyd, The Genus Lycoperdon in Europe, t. 53, figs. 9—11.

Reykjavík and Mývatn [Grønlund]; Hofsfjall in Hörgárdalur, Hlöð Þrastarhólsskarð, Stórá Brekka [O. D.].

617. **L. caelatum** Bulliard, Sacc., Syll. fung. VII, p. 115.

Grímstunga [Grønlund]; meadow by Mývatn [P. L.]

Nidulariaceae.

Crucibulum Tulasne.

618. **C. vulgare** Tulasne, Sacc., Syll. fung. VII, p. 43.

Ólufsdalur [H. J.]. Seyðisfjörður [P. L.]. Reykjavík [Buchwald]. — On dead wood.

FUNGI IMPERFECTI

Sphaerioidaceae-Hyalosporae.

Phyllasticta Persoon.

619. **P. Elymi** (Rostrup) Allescher, Rabenhorst's Krypt. Flora I, 7., p. 763.

Phoma Elymi Rostrup, Botanisk Tidsskrift 1899, p. 276.

Grímstaðir near Jökulsá á Fjöllum [P. L.]. — On awns of Elymus.

620. **P. Pseudacori** (Brun) Allescher, Rabenhorst's Krypt. Flora I, 6., p. 160.

Garden in Reykjavík [P. L.]. — On leaves of Iris germanica.

621. **P. Ranunculorum** Saccardo et Spegazzini, Michelia I, p. 150. — Syll. fung. III, p. 37.

Storugjá near Mývatn [O. D.]. — On a leaf of Ranunculus acer.

622. **P. filipendulina** Saccardo et Spegazzini, Michelia I, p. 150. — Syll. fung. III, p. 41.

Sponstaðir [Feddersen]. — On leaves of Filipendula ulmaria.

Phoma (Fries) Desmazières.

623. **P. muscorum** Rostrup, Isl. Svampe 1903, p. 318.

Hestahraun in Þorvaldsdalur [O. D.]. — On Tetraplodon bryoides.

624. **P. Equiseti** Desmazières, Sacc., Syll. fung. III, p. 168.

Hof [O. D.]. — On Equisetum palustre.

625. **P. Lycopodii** Rostrup, Isl. Svampe 1903, p. 318.

Möðruvellir [St. St.]. — On Lycopodium annotinum.

626. **P. Tofieldiae** Rostrup, Isl. Svampe 1885, p. 226.

Hof in Hörgárdalur [O. D.]; also gathered in Iceland by J. Mortensen. — On Tofieldia borealis.

627. **P. salicina** Westendorp, Sacc., Syll. fung. III, p. 97.

Hörgárdalur [O. D.]. — On twigs of Salix phylicifolia.

628. **P. endoleuca** Saccardo, Syll. fung. III, p. 98.

A garden in Reykjavík [Prytz]. — On Alnus glutinosa.

629. **P. urticae** Schulzer et Saccardo, Syll. fung. III, p. 140.

Efsta-Samtún [O. D.]. — On stems of Urtica dioeca.

630. **P. acuta** Fuckel, Sacc., Syll. fung. III, p. 133.

Reykjavík [H. J.]. — On stems of Atriplex patula.

631. **P. tingens** Cooke et Massee, Grevillea XVII, p. 56. — Sacc., Syll. fung. IX, p. 166.

Reykjavík (The Experimental Station) [P. L.], det. O. Rostrup. — On stems of Aconitum sp.

632. **P. oleraceum** Saccardo, Syll. fung. III, p. 135.

The Experimental Station at Reykjavík [P. L.], det. O. Rostrup. — On stems of Erysimum sp.

633. **P. Malvacei** Brunaud, Flore myc. Saint. et Four. in Bull. Soc. Sc. Nat. de l'Ouest.

A garden in Reykjavík [P. L.], det. O. Rostrup. — On Ribes alpinum.

634. **P. ribicola** Saccardo, Syll. fung. III, p. 17.

A garden in Reykjavík [Prytz]. — On Ribes rubrum.

635. **P. Saxifragarum** Westendorp, Notes sur quelques cryptogames VI, p. 23. — Sacc., Syll. fung. III, p. 145.

Hofsfjall [O. D.]. — On stems of Saxifraga nivalis.

636. **P. Alchimillae** Rostrup, Isl. Svampe 1903, p. 318.

Hof in Hörgárdalur [O. D.]. — On leaves of Alchimilla alpina.

637. **P. ruborum** Westendorp, Sacc., Syll. fung. III, p. 76.

Vífilsstaðahlíð [P. L.], det. O. Rostrup. — On branches of Rubus saxatilis.

638. **P. melaena** (Fries) Durand et Montagne, Sacc., Syll. fung. III, p. 315.

Grund near Akureyri [P. L.], det. O. Rostrup. — On stems of Vicia cracca.

639. **P. complanata** (Tode) Desmazières, Saccardo, Syll. fung. III, p. 126.

Hof [O. D.]; Skriða in Hörgárdalur, Grund in S. W. Iceland [H. J.]. — On stems of Archangelica officinalis, Rhinanthus crista-galli.

640. **P. Armeriae** Jaap. Schriften der Nat. Verein für Schleswig-Holstein, Bd. XIV (1907), Heft I. p. 28.

Akureyri [P. L.]. — On stems of Armeria maritima f. elongata.

641. **P. solanicola** Prillieux et Delacroix, Saccardo, Syll. fung. X, p. 175.

Hof [O. D.]; Eyðar [P. L.], det. O. Rostrup. — On stems of Solanum tuberosum.

642. **P. Sceptri** Karsten, Saccardo, Syll. fung. III, p. 129.

Hraun in Fljót, Hof, Reistarárgil, Torfastaðadalur [O. D.]. — On Pedicularis sp., Bartsia alpina.

643, **P. deusta** Fuckel, Symbolae, p. 377. — Saccardo, Syll. fung. III, p. 155.

Hof [O. D.]. — On capsules and bracts of Rhinanthus crista-galli.

644. **P. herbarum** Westendorp, Saccardo, Syll. fung. III, p. 133.

Common throughout the country. — On Euphrasia latifolia, Bartsia alpina, Thymus serpyllum etc.

Phomopsis Saccardo.

645. **P. ribesia** (Saccardo) Diedicke, Annales Mycologici IX, p. 29.

Phoma ribesia Saccardo, Micheliana I, p. 520.

A garden in Reykjavík [P. L.], det. O. Rostrup. — On Ribes rubrum.

Aposphaeria Berkeley.

646. **A. pulviuscula** Saccardo, Syll. fung. III, p. 175.

A garden in Akureyri [P. L.], det. O. Rostrup. — On dead branches of Salix phylicifolia.

647. **A. glomerata** (Corda) Saccardo, Syll. fung. III, p. 175.

Coniothyrium glomeratum Corda, Icones IV, p. 39.

The Experimental Station in Reykjavík [P. L.], det. O. Rostrup. — On dead branches of Ulmus montana.

648. **A. subtilis** (Fries) Saccardo, Syll. fung. III, p. 171.

Sphaeronema subt. Fries in Kunze et Schmidt, Mycol. Hefte II, p. 57.

A garden in Akureyri [P. L.], det. O. Rostrup. — On dead branches of Sorbus aucuparia.

649. **A. arctica** (Karsten) Saccardo, Syll. fung. III, p. 176.

Phoma arctica Karsten, Hedwigia 1884, p. 19.

Krossastaðagil [O. D.]. — On a decorticated branch in a raven's nest.

650. **A. labens** Saccardo, Syll. fung. III, p. 173.

Möðruvellir [O. D.]. — On wood.

Dendrophoma Saccardo.

651. **D. marchica** Diedicke, Kryptogamen-Flora der Mark Brandenburg, Bd. IX, p. 198.

The Experimental Station at Reykjavík and Vífilsstaðahlíð [P. L.], det. O. Rostrup. — On Rumex domesticus.

Asteroma De Candolle.

652. **A. Salicis** Roberge, Saccardo, Syll. fung. III, p. 208.

Sörlastaðarunnar [St. St.]. — On leaves of Salix phylicifolia.

653. **A. Capreae** Desmazières, Saccardo, Syll. fung. III, p. 208.

Hálsskógur [O. D.]. — On leaves of Salix phylicifolia.

654. **A. alpinum** Saccardo, Syll. fung. III, p. 206.

Aðaldalshraun [O. D.]. — On leaves of Arctostaphylos uva ursi.

Vermicularia Fries.

655. **V. Liliacearum** Westendorp, Saccardo, Syll. fung. III, p. 233.

Hofsfjáll [O. D.]. — On stems of Luzula multiflora.

656. **V. trichella** Fries in Greville, Scottish cryptogamic Flora, t. 345, et Sum. Veg. Scand., p. 420.

Haukadalur [Feddersen]. — On leaves of Salix sp.

657. **V. Dematium** (Persoon) Fries, Saccardo, Syll. fung. III, p. 225.

Vífilsstaðahlíð [P. L.], det. O. Rostrup. — On dead stems of Rumex acetosa.

658. **V. Geranii** Westendorp, Exs. No. 1239, Flore cryptogamique des Flandres I, p. 404.

Vífilsstaðahlíð [P. L.], det. O. Rostrup. — On dead stems of Geranium silvaticum.

Placosphaeria Saccardo.

659. **P. Bartsiae** C. Massal., Saccardo, Syll. fung. X, p. 235.

Bog near Hallormstaðir [P. L.], det. O. Rostrup. — On Bartsia alpina.

660. **P. Galii** Saccardo, Syll. fung. III, p. 245.

Almannagjá near Þingvellir [P. L.], det. O. Rostrup. — In the same stroma as *Mazzantia Galii* on stems of Galium verum.

Cytospora Ehrenberg.

661. **C. Salicis** (Corda) Rabenhorst, Saccardo, Syll. fung. III, p. 261.

Þórðarstaðir [O. D.]. — On branches of Salix phylicifolia.

662. **C. betulina** Ehrenberg, Sylvae Mycologicae Berolinenses, p. 28. — Saccardo, Syll. fung. III, p. 259.

Akureyri [P. L.]. — On branches of Betula pubescens.

663. **C. leucostoma** (Persoon) Saccardo, Syll. fung. III, p. 254.

A garden in Reykjavík [P. L.]. — On branches of Prunus padus.

664. **C. Massariana** Saccardo, Syll. fung. III, p. 253.

A garden in Akureyri [P. L.], det. O. Rostrup. — On dead branches of Sorbus aucuparia.

665. **C. microspora** (Corda) Rabenhorst, Saccardo, Syll. fung. III, p. 253.

A garden in Reykjavík [Prytz]. — On branches of Sorbus aucuparia.

Rabenhorstia Fries.

666. **R. rudis** Fries, Saccardo, Syll. fung. III, p. 243.

A garden in Akureyri [P. L.], det. O. Rostrup. — On pieces of bark of Cytisus laburnum.

Sphaerioidaceae-Phaeosporae.

Coniothyrium Corda.

667. **C. myriocarpum** (Fries) Saccardo, Syll. fung. III, p. 315.

Hof [O. D.]. — On wood.

668. **C. lignorum** Saccardo, Syll. fung. III, p. 315.

Cliosporium lignorum Fries, Syst. Myc. III, p. 335.

Hof, Húsafellsskógur, Hálsskógur [O. D.]. — On birch-wood.

669. **C. Laburni** Richards, Cat. Champ. Marn. 1889, No. 1645. — Saccardo, Syll. fung. X, p. 264.

Garden in Reykjavík [Prytz]. — On Cytisus laburnum.

670. **C. olivaceum** Bonorden, Saccardo, Syll. fung. III, p. 305.

The Experimental Station at Reykjavík [P. L.], det. O. Rostrup. — On branches of Ulmus montana.

671. **C. conoideum** Saccardo, Syll. fung. III, p. 316.

Skriða in Hörgárdalur [O. D.]. — On stems of Archangelica officinalis.

Sphaerioidaceae-Hyalodidymae.

Ascochyta Libert.

672. **A. teretiuscula** Saccardo et Roumerque, Saccardo, Syll. fung. III, p. 405.

Hrafnagiá [P. L.], det. O. Rostrup. — On withered bracts of Luzula spicata.

673. **A. baccae** Rostrup, Grønl. Svampe 1891, p. 625. — Saccardo, Syll. fung. XI, p. 524.

Þrastarhólsskarð [O. D.]. — On berries of Empetrum nigrum.

674. **A. Diapensiae** Rostrup, Øst-Grønlands Svampe 1894, p. 28. — Saccardo, Syll. fung. XI, p. 524.

Hofsfjall [O. D.]. — On leaves of Diapensia lapponica.

675. **A. Veronicae** Rostrup, Isl. Svampe 1903, p. 319.

Möðruvellir [O. D.]. — On leaves of Veronica saxatilis.

Diplodina Westendorp.

676. **D. Eurhododendri** Voss, Saccardo, Syll. fung. X, p. 312.

Hof [O. D.]. — On berries of Vaccinium uliginosum.

Darluca Castagne.

677. **D. Filum** (Bivon.) Cast., Saccardo, Syll. fung. III, p. 410.

Akureyri [Strömfelt]. — Parasitic on a Uredo on Poa pratensis.

Sphaerioidaceae-Phaeodidymae.

Diplodia Fries.

678. **D. Rubi** Fries, Sum. Veg. Scand., p. 417.

The Experimental Station at Reykjavík [P. L.]. — On dry branches of Rubus Idaeus.

Sphaerioidaceae-Hyalophragmiae.

Stagonospora Fries.

679. **S. Equiseti** Fautrey, Saccardo, Syll. fung. X, p. 337.

Ós in Hörgárdalur [O. D.]; Eyjarfjarðardalur near Akureyri [P. L.]. — On Equisetum palustre.

680. **S. islandica** Rostrup, Isl. Svampe 1903, p. 320.

Grímsey [O. D.]. — On leaf sheaths of a grass.

681. **S. graminella** Saccardo, Syll. fung. III, p. 454.

Möðruvellir, Hof, Gásir [O. D.]. — On Deschampsia caespitosa and Poa pratensis.

682. **S. curvula** Bom. et Rous., Saccardo, Syll. fung. X, p. 337.

Grímstaðir near Jökulsá á Fjöllum [P. L.]. — On Elymus arenarius.

683. **S. aquatica** Saccardo, Syll. fung. III, p. 452.

Hornafjarðareyjar [St. St.]. — On stems of Heleocharis palustris.

684. **S. Galii** Fautrey, Revue mycologique 1892, p. 177. — Saccardo, Syll. fung. XI, p. 524.

Hallormstaðir [P. L.], det. O. Rostrup. — On Galium pumilum.

Sphaerioidaceae-Phaeophragmiae.

Hendersonia Berkeley.

685. **H. Jungermanniae** Fries, E. Rostrup, Isl. Svampe 1903, p. 320.

Mulá [O. D.].

686. **H. silvatica** Fautrey, Revue mycologique 1894, p. 160. — Saccardo, Syll. fung. XI, p. 532.

Sluttnes in Mývatn [P. L.], det. O. Rostrup. — On Poa alpina.

687. **H. arundinacea** (Desmazières) Saccardo, Syll. fung. III, p. 436.

Grimstaðir near Jökulsá á Fjöllum [P. L.]. — On straws of Elymus arenarius.

688. **H. Stefanssonii** Rostrup, Isl. Svampe 1903, p. 320.

Rjettarhól [St. St.]. — On leaves of Carex hyperborea.

689. **H. Caricis** Oudemans, Mater. Flor. myc. de la Neerlande II, p. 19.

Hofsfjall [O. D.]. — On leaves of Carex atrata.

690. **H. salicina** Saccardo, Syll. fung. III, p. 425.

Túngá, Foss [Feddersen]. — On willow branches.

691. **H. Ribis alpini** Fautrey, Revue mycologique 1892, p. 171. — Saccardo, Syll. fung. XI, p. 529.

A garden in Reykjavík [P. L.], det. O. Rostrup. — On Ribes alpinum.

Sphaerioidaceae-Phaeodictyae.

Camarosporium Schulzer.

692. **C. laburnicum** Saccardo, Syll. fung. X, p. 339.

The Experimental Station at Reykjavík [P. L.], det. O. Rostrup. — On Cytisus alpinum.

Cytosporium Peck.

693. **C. betulinum** Rostrup, Isl. Svampe 1903, p. 320.

Hálsskógur [O. D.]. — On rotten wood of Betula pubescens.

694. **C. Davidssonii** Rostrup, Isl. Svampe 1903, p. 320.

Gásir [O. D.]. — On wood.

Sphaerioidaceae-Scolecosporae.

Septoria Fries.

695. **S. graminum** Desmazières, Saccardo, Syll. fung. III, p. 565.

Hestahraun in Þorvaldsdalur [O. D.]. — On leaves of Poa alpina.

696. **S. punctoidea** Karsten, Fragmenta mycologica, Hedwigia 1884, p. 38.

Hof in Hörgárdalur [O. D.]. — On Cobresia scirpina.

697. **S. Caricis** Passerini, Saccardo, Syll. fung. III, p. 566.

Grímsey, Hallgilsstaðafjall [O. D.]. — Carex vaginata and Carex nardina.

698. **S. Orchidearum** Westendorp, Exs. No. 638, Kickx, Flore cryptogamique des Flandres I, p. 423. — Saccardo, Syll. fung. III, p. 575.

Stórugjá near Mývatn [O. D.]; Ós in Hegranes [Olafsson]. — On Coeloglossum viride.

699. **S. salicella** Berkeley et Broome, Annals and Magazin of Natural History, No. 746, tab. XV, fig. 7. — Saccardo, Sylloge f. III, p. 585.

Bægisárgíl [O. D.]; Laugardalur [Grønlund]. — On branches of Salix lanata and Salix glauca.

700. **S. salicina** Peck, Reports New York Museum, p. 87. — Saccardo, Syll. fung. III, p. 502.

Goðaland [Feddersen]. — On leaves of a Salix sp.

701. **S. Capreae** Westendorp, Bulletin Academie Royale de Botanique de Belgique, II. Serie, tome XI, No. 6. — Saccardo, Syll. fung. III, p. 501.

Mývatnsheiði [O. D.]; Svinahraun [Feddersen]. — On buds of Salix lanata.

702. **S. betulina** Passerini, Saccardo, Syll. fung. III, p. 506.

Mývatn [Grønlund]. — On branches of Betula sp.

703. **S. cerasticola** Rostrup, Isl. Svampe 1903, p. 321.

Grimsey [O. D.]. — On leaves of Cerastium alpinum.

704. **S. Stellariae** Roberge et Desmazières. Saccardo. Syll. fung. III. p. 518.

Ós in Möðruvallasókn, Reistarárskarð [O. D.]. — On leaves of Cerastium alpinum.

705. **S. Alsines** Rostrup, Isl. Svampe 1903, p. 321.

Hofsfjall [O. D.]. — On leaves and stems of Alsine verna.

706. **S. Geranii** Roberge et Desmazières, Annales des Sciences Naturelles. Botanique 1853, XX, p. 93. — Saccardo, Syll. fung. III, p. 514.

Store Gjá near Reykjahlíð [P. L.], det. O. Rostrup. — On petioles of Geranium silvaticum.

707. **S. semilunaris** Johanson, Svampar från Isl., 1884, p. 173.

Grafarós [St. St.]; Eskifjörður [Strömfelt]; Hofsfjall, Mývatnsheiði [O.D.]. — On internodes of Rumex acetosa, Parnassia palustris, Geranium silvaticum, Dryas octopetala, Plantago maritima and Erigeron sp.

708. **S. Viciae** Westendorp, Saccardo, Syll. fung. III, p. 509.

Lónshólmi [O. D.]. — On leaves of Vicia cracca.

709. **S. Galiorum** Ellis, Bull. Torrey, bot. club, 1882, p. 74. — Saccardo, Syll. fung. III, p. 543.

Hraun in Fljót [O. D.]. — On stems of Galium verum.

Rhabdospora Montagne.

710. **R. curva** (Karsten) Allescher, Rabenhorst's Krypt. Flora I, 6, p. 916.

Septoria curva Karsten, Symbolae XXI, p. 103.

Grímstaðir near Jökulsá á Fjöllum [P. L.], det. O. Rostrup. — On dead stems and leaves of Elymus arenarius.

711. **R. pleosporoides** Saccardo, Syll. fung. III, p. 588.

Hestahraun, Hofsfjall, Fornhagagil [O. D.]; Möðruvellir [St. St.]; Reykjavík [H. J.]. — Rumex domesticus, R. acetosa, R. acetosella, Oxyria digyna, Polygonum viviparum, Geum rivale.

712. **R. inaequalis** Saccardo, Syll. fung. III, p. 580.

Sluttnes in Mývatn [P. L.], det. O. Rostrup. — On bark of Sorbus aucuparia.

713. **R. eupyrenoides** Saccardo, Grevillea XXI, p. 67, tab. 184, fig. 9. — Syll. fung. XI, p. 549.

Möðruvellir, Hof in Hörgárdalur [O. D]; Svínhagi [Feddersen]. — On stems of Euphrasia latifolia.

Nectrioidaceae.

Zythia Fries.

714. **Z. islandica** Rostrup (in mscr.).

Rhraun in Fljótum [O. D.].

Peritheciis superficialibus gregariis, globosis, 0.3 mm diam., vitellinis, glabris. Sporulis sphaeroideis, 4—5 μ cr., asperulis, hyalinis. Ad terram turfosam.

Leptostromaceae-Hyalosporae.

Leptothyrium Kunze et Schmidt.

715. **L. vulgare** (Fries) Saccardo, Syll. fung. III, p. 633.

Ísafjörður [H. J.]. — On stems of Cornus suecica.

Piggotia Berkeley et Broome.

716. **P. atronitens,** Oudemans, Nat. Myc. Neerl. II, p. 21. — Saccardo, Syll. fung. III, p. 637.

Sandá near Hestahraun [Feddersen]. — On branches of Salix sp.

Leptostroma Fries.

717. **L. caricinum** Fries, Syst. Myc. II, p. 598.

Melar, Mývatn, Hrútafjörður [Grønlund]; Jórudalur, Ejafjörður [Strömfelt]; Þingmuli [H. J.]. — On Carex Goodenoughi, Carex alpina, Carex rigida, Carex lagopina, Carex sp.

718. **L. punctiforme** Wallroth, Flora Cryptogamica Germaniae No. 1395. — Saccardo, Syll. fung. III, p. 642.

Möðruvellir [O. D.]. — On leaves of Salix glauca.

719. **L. Potentillae** Karsten, Fungi in insulis Spetsbergen 1872, p. 59. — Saccardo, Syll. fung. III, p. 647.

Reykjavík [Krabbe]; Skútustaðir near Mývatn [O. D.]. — On leaves of Potentilla maculata.

720. **L. herbarum** (Fries) Link, Saccardo, Syll. fung. III, p. 645.

On stems of Carum carvi.

Leptostromaceae-Hyalophragmiae.

Discosia Libert.

721. **D. Artocreas** (Tode) Fries, Sum. Veg. Skand., p. 653.

Hof, Fornhagagil, Laugardalshólar [O. D.]; Þingmúli [H. J.]. — On Alchimilla alpina, Geum rivale, Thalictrum alpinum, Betula pubescens, Salix herbacea.

Excipulaceae-Hyalosporae.

Excipula Fries.

722. **E. sphaeroides** (Persoon) Fries, Syst. Myc. II, p. 191.

Hestahraun in Þorvaldsdalur [O. D.]. — On leaves of Salix glauca.

723. **E. Empetri** Fries, Syst. Myc. II, p. 190.

Mōðruvellir [St. St.]; Hof. Þrastarhólsgil [O. D.]. — On leaves of Empetrum nigrum.

Dothichiza Libert.

724. **D. Sorbi** Libert, Saccardo, Syll. fung. III, p. 671.

Reykjavík [Prytz]. — On bark of Sorbus aucuparia.

Excipulaceae-Hyalophragmiae.

Heteropatella Fuckel.

725. **H. cercosperma** (Rostrup) Lind, Danish Fungi, p. 473.

Septoria cercosperma Rostrup, Mykologiske Notitser i Sverige. — Öfvers. Vet. Ak. 1883, No. 4, pp. 35—47. Of common occurrence on the stems of many different herbaceous plants, as Gnaphalium norvegicum, Hieracium alpinum, Carum carvi, Archangelica officinalis, Ranunculus acer, Arabis petraea.

Melanconiaceae-Hyalosporae.

Gloeosporium Desmazières et Montagne.

726. **G. filicinum** Rostrup in Thümen Myc. No. 2083.

Herpobasidium filic. (R.) Lind, Arkiv f. Botanik, vol. 7, No. 8, pp. 1—9.

Husavík [O. D.]. — On Dryopteris pulchella.

727. **G. alpinum** Saccardo, Syll. fung. III, p. 708.

Húsafell [H. J.]. — On Arctostaphylos uva ursi.

Myxosporium Link.

728. **M. salicinum** Saccardo et Roumerque, Syll. fung. III, p. 724.

The Experimental Station and a garden in Reykjavík [P. L.], det. O. Rostrup. — On Salix phylicifolia.

729. **M. Aucupariae** Allescher, Berichte d. Bayer. Bot. Gesellsch., vol. IV 1896, p. 36. — Saccardo, Syll. fung. XIV, p. 1014.

Skipalón [O. D.]. — On branches of Sorbus aucuparia.

Melanconiaceae-Phaeosporae.

Melanconium Link.

730. **M. elevatum** (Fries) Lind, Danish Fungi, p. 483.

Didymosporium elev. Fries, Systema mycologicum III, p. 486.
Melanconium betulinum Kuntze, Saccardo, Syll. fung. III, p. 756.

Þingvellir [Feddersen]. — On branches of birch.

731. **M. bicolor** Fries, Syst. Myc. III, p. 488.

Húsafellsskógur [O. D.]. — On branches of birch.

Melanconiaceae-Hyalodidymae.

Marssonina Magnus.

732. **M. Potentillae** (Desmazières) Magnus, Saccardo, Syll. fung. III, p. 770.

Hof, Skrifla (S. W. Iceland) [O. D.]. — On living leaves of Potentilla anserina and Comarum.

Melanconiaceae-Hyalophragmiae.

Septogloeum Saccardo.

733. **S. Fragariae** (Briand et Har.) v. Höhnel, Mycologische Fragmente, Ann. Myc. I, pp. 391—414.

Hof [O. D.]. — On leaves of Comarum palustre.

Melanconiaceae-Phaeodictyae.

Steganosporium Corda.

734. **S. traphinum** Saccardo, Syll. fung. II, p. 290.

The plantation at Grund south of Akureyri [P. L.], det. O. Rostrup. — On dead branches of Populus tremula.

Mucedinaceae-Hyalosporae.

Chromosporium Corda.

735. **C. croceum** (Montagne) Saccardo, Syll. fung. IV, p 7.

Möðruvellir [St. St.]. — On rotten agarics.

736. **C. vitellinum** Saccardo, Syll. fung. IV, p. 7.

Grímsey, Hof, Fagriskógur [O. D.]; Möðruvellir, Víðvik [St. St.]. — On fish-bones, skin, and horse-dung.

737. **C. lateritium** (Berkeley et Broome), Saccardo, Syll. fung. IV, p. 5.

Hof [O. D.]. — On a bone.

738. **C. album** (Corda) Saccardo, Syll. fung. IV, p. 8.

Gymnosporium album Corda, Icones fung. I, p. 1, fig. 10.

Hofsfjall, Hálsskógur [O. D.]. — On leaves of Oxyria and of birch.

Oospora Wallroth.

739. **O. nivea** (Fuckel) Saccardo, Syll. fung. IV, p. 16.

Grímsey, Hof, Fagriskógur [O. D.]. — On the skeleton of a fish, in a sheep-fold and in a haybarn.

740. **O. rosella** Grove, Saccardo, Syll. fung. IV, p. 63.

Hof [O. D.]. — On horse-dung.

741. **O. coccinea** (Corda) Saccardo, Syll. fung. IV, p. 21.

Vallanes [H. J.]. — On wood.

Fusidium Link.

742. **F. punctiforme** Schlecht., Botanische Zeitung 1852, p. 617.

Hof [O. D.]. — On living leaves of Epilobium palustre.

Trichoderma Persoon.

743. **T. viride** Persoon, Synops. meth. fung., p. 230.

Hof [O. D.]. — On wood in a stable and on cardboard.

744. **T. cinnabarinum** Wallroth, Saccardo, Syll. fung. IV, p. 61.

Möðruvellir [St. St.]. — On woodwork in a sheep-fold.

Sporotrichum Link.

745. **S. griseum** Link, Observationes mycologicae I, p. 11. — Saccardo, Syll. fung. IV, p. 110.

Möðruvellir [St. St.]. — On food in a cellar.

Ovularia Saccardo.

746. **O. obliqua** (Cooke) Oudemans, Saccardo, Syll. fung. IV, p. 145.

Möðruvellir, Hraun in Fljót [O. D.]; Hvammur, Kvennabrekka [H. J.]; Reykjavík (Grønlund); Drangshlíð, Vallanes [H. J.]. — On living leaves of Rumex domesticus.

747. **O. rigidula** Delacroix, Saccardo, Syll. fung. X, p. 541.

Hof [O. D.]. — On living leaves of Polygonum aviculare.

748. **O. decipiens** Saccardo, Syll. fung. IV, p. 139.

Hólar in Hjaltadalur [St. St.]. — On living leaves of Ranunculus acer.

749. **O. alpina** Massee, Saccardo, Syll. fung. X, p. 542.

Fornhagagil [O. D.]. — On living leaves of Alchimilla alpina.

Botrytis Micheli.

750. **B. vulgaris** Fries, Syst. Myc. III, p. 398.

Hestahraun in Þorvaldsdalur [O. D.]. — On Alchimilla alpina.

751. **B. cinerea** Persoon, Synops. meth. fung., p. 690.

Hestahraun in Þorvaldsdalur, Fornhagagil, Hof [O. D.]; Krökur in S. Iceland [H. J.]. — On Hieracium murorum, Geranium silvaticum, Polygonum aviculare, Geum rivale, Sibbaldia procumbens.

Verticillium Nees.

752. **V. lateritium** Berkeley, Saccardo, Syll. fung. IV, p. 156.

Hof [O. D.]. — On fish-skin.

Mucedinaceae-Hyalodidymae.

Trichothecium Link.

753. **T. roseum** Fries, Syst. Myc. III, p. 427.

Hlíðarfjall near Mývatn [P. L.], det. O. Rostrup. — On ptarmigan droppings.

Arthrobotrys Corda.

754. **A. superba** Corda, Saccardo, Syll. fung. IV, p. 181.

Seyðisfjörður [P. L.], det. O. Rostrup. — On sheep dung.

Bostrychonema

755. **B. alpestre** Cesati, Saccardo, Syll. fung. IV, p. 185.

Mývatnsheiði [O. D.]. — On leaves of Polygonum viviparum.

Mucedinaceae-Phragmosporae.

Mastigosporium Ries.

756. **M. album** Ries in Fresenius, Beitr., p. 56, tab. VI. — Saccardo, Syll. fung. IV, p. 220.

Dalsmynni (S. W. Iceland) [H. J.]. — On Agrostis vulgaris and Hierochloa borealis.

Monacrosporium Oudemans.

757. **M. elegans** Oudemans, Niederlandsch Kruidkundig Archief, 2. Ser. IV, 250 (1884), Tab. V, fig. 9. — Saccardo, Syll. fung. IV, p. 493.

Hlíðarfiall near Mývatn [P. L.], det. O. Rostrup. — On ptarmigan droppings.

Ramularia Unger.

758. **R. Bistortae** Fuckel, Symbolae, p. 361.

Hofsfjall, Hestahraun in Þorvaldsdalur [O. D.]. — On leaves of Polygonum viviparum.

759. **R. aequivoca** (Cesati) Saccardo, Syll. fung. IV, p. 201.

Hof, Rhaun in Fljót [O. D.]. — On leaves of Ranunculus acer, R. repens.

760. **R. lactea** (Desmazières) Saccardo, Syll. fung. IV, p. 201.

Hof [O. D.]. — On leaves of Viola canina and V. tricolor.

761. **R. Chamaenerii** Rostrup, Isl. Svampe 1885, p. 229. — Syll. fung. X, p. 577.

Herðubreiðarlindir [Thoroddsen]. — On leaves of Chamaenerium latifolium.

762. **R. punctiformis** (Schlecht.) v. Höhnel, Saccardo, Syll. fung. IV, p. 453.

A garden in Reykjavík [H. J.]. — On Chamaenerium angustifolium.

763. **R. Archangelicae** Lindroth. Saccardo, Syll. fung. XVIII, p. 551.

Sluttnes in Mývatn [P. L.], det. O. Rostrup. — On Archangelica officinials.

764. **R. Bartsiae** Johanson, Svampar från Isl. 1884, p. 173.

Eskifjörður [Strömfelt]. — On leaves of Bartsia alpina.

765. **R. filaris** Fresenius, Saccardo, Syll. fung. IV, p. 210.

Hestahraun in Þorvaldsdalur [O. D.]. — On leaves of Gnaphalium norvegicum.

766. **R. Taraxaci** Karsten, Saccardo, Syll. fung. IV, p. 207.

Hof [O. D.]. — On leaves of Taraxacum officinale.

Dematiaceae-Phaeosporae.

Coniosporium Link.

767. **C. aterrimum** (Corda) Saccardo, Syll. fung. IV, p. 240.

Gymnosporium a. Corda, Icones fung. II, p. 1, tab. 8, fig. 2.

Mývatn [O. D.]. — On a decorticated branch.

768. **C. fusidioides** (Corda) Saccardo, Syll. fung. IV, p. 242.

Gymnosporium fusidioides Corda, Icones fungorum, p. 1, fig. 16.

Möðruvellir [O. D.]. — On timber.

769. **C. variabile** (Peck) Saccardo, Syll. fung. IV, p. 241.

Gymnosporium v. Peck, Reports New York Museum, vol. 33, p. 27.

Gásir [O. D.]. — On wood.

770. **C. melanconidium** Saccardo, Syll. fung. IV, p. 239.

Hálsskógur [O. D.]. — On Arcthostaphylos uva ursi.

Torula Persoon.

771. **T. epizoa** Corda var. muriae Kickx, Flore cryptogamique des Flandres II, p. 299. — Saccardo, Syll. fung. IV, p. 261.

Reykjavík [H. J.]. — On split cod.

Hormiscium Kunze.

772. **H. stilbosporum** (Corda), Saccardo, Syll. fung. IV, p. 264.

Brunastaðahólmi [O. D.]. — On Salix sp.

773. **H. betulinum** Karsten, Symbolae ad mycologiam fennicam XXV, p. 25. — Saccardo, Syll. fung. IV, p. 575.

Hof in Hörgárdalur [O. D.]. — On bark of Betula nana.

774. **H. altum** Ehrenberg, Sylvae Mycologicae Berolinensis, p. 10 et 12. — Saccardo, Syll. fung. IV, p. 263.

Hálsskógur [O. D.]. — On Betula pubescens.

Periconia Bonorden.

775. **P. alternata** (Berkeley) Saccardo, Syll. fung. IV, No. 1332.

Hof [O. D.]. — On woodwork and cardboard.

Arthrinium Kunze.

776. **A. bicorne** Rostrup, Botanisk Tidsskrift, vol. 15, p. 235.

Hofsfjall [O. D.]. — On Juncus balticus and J. trifidus.

Goniosporium Link.

777. **G. puccinioides** (Fries) Link, Saccardo, Syll. fung. IV, p. 280.

Arthrinium pucc. Kunze, Fries: Systema mycologicum III, p. 376.

Möðruvellir, Hof [O. D.]; Spónsgerði [St. St.]; Hurðarós [Thoroddsen]; Eskifjörður [Strömfelt]. — On Carex rigida and Cobresia scirpina.

Hadrotrichum Fuckel.

778. **H. virescens** Saccardo et Roumerque, Syll. fung. IV, p. 301.

Hof in Hörgárdalur [O. D.]. — On Agrostis alba.

Dematiaceae-Phaeodidymae.

Fusicladium Bonorden.

779. **F. Angelicae** (Fries) Lind, Danish Fungi, p. 521.

F. depressum (Berkeley et Broome) Saccardo, Syll. fung. IV, p. 346.

Marðarnupsgil, Hörgárdalur [St. St.]. — On living leaves of Angelica silvestris and Archangelica officinalis.

Scolecotrichum Kunze et Schmidt.

780. **S. graminis** Fuckel, Saccardo, Syll. fung. IV, p. 348.

Grímsey, Hof, Möðruvellir, Hestahraun in Þorvaldsdalur [O. D.]; Eyjafjörður, Vogar near Mývatn [Strömfelt]. — On Glyceria distans, Alopecurus geniculatus, Agropyrum violaceum and Phleum pratense.

Cladosporium Link.

781. **C. lycoperdinum** Cooke in Ravenel Amer. Fungi, No. 595 et in Grevillea 1883, p. 32. — Saccardo, Syll. fung. IV, p. 368.

Rhaun in Fljót [O. D.]. — On Bovista nigrescens.

782. **C. graminum** Corda, Saccardo, Syll. fung. IV, p. 365.

Common on grasses: Poa alpina, P. caesia, Festuca ovina, F. rubra, Trisetum subspicatum etc.

783. **C. perpusillum** Saccardo, Syll. fung., p. 364.

Grímsey [O. D.]. — On straws of Elymus arenarius.

784. **C. caricicola** Corda, Saccardo, Syll. fung. IV, p. 365.

The plantation at Grund near Akureyri, a bog near Hallormstaðir [P. L.]. — On Carex rigida and Cobresia scirpina.

785. **C. entoxylinum** Corda, Saccardo, Syll. fung. IV, p. 353.

Möðruvellir, Hálsskógur, Hraun in Fljót [O. D.]. — On wood.

786. **C. herbarum** (Persoon) Link, Saccardo, Syll fung. IV, p. 350.

Throughout the country on dead stems of many different plants, as: Selaginella, Juncus arcticus, Rumex domesticus, Arenaria ciliata, Viscaria alpina, Cardamine bellidifolia, Saxifraga caespitosa, Matricaria inodora.

Dematiaceae-Phaeophragmiae.

Cercospora Fresenius.

789. **C. Paridis** Eriksson, Saccardo, Syll. fung. IV, p. 476.

C. Paridis Rostrup, Mykologiske Notitser i Övers.Vet.Akad. 1883, No. 4.

Buðir [Grønlund]. — On leaves of Paris quadrifolia.

Dematiaceae-Phaeodictyae.

Coniothecium Corda.

788. **C. applanatum** Saccardo, Syll. fung. IV, p. 508.

Þjorsárdalur [O. D.]. — On wood.

789. **C. betulinum** Corda, Saccardo, Syll. fung. IV, p. 510.

Hlöð, Hálsskógur [O. D.]; Þingvellir [P. L.]. — On wood of Betula nana and B. pubescens.

790. **C. effusum** Corda, Saccardo, Syll. fung. IV, p. 508.

Hálsskógur [O. D.]. — On birch-wood.

Stemphylium Walroth.

791. **S. atrum** (Preuss) Saccardo, Syll. fung., p. 520. — Ulocladium atrum Preuss in Linnaea vol. 25 1852, p. 75.

Arnarnes [O. D.]. — On drift-wood.

Macrosporium Fries.

792. **M. commune** Rabenhorst, Saccardo, Syll. fung. IV, p. 524.

Common on dead parts of many different plants, as: Archangelica, Rhodiola, Cochlearia, Cerastium, Oxyria, Elymus and several others.

Phaeostilbaceae.

Isariopsis Fries.

793. **I. pusilla** Fresenius, Beitr. t. XI, fig. 18—28.

I. albarosella (Desmazières), Saccardo, Syll. fung. IV, p. 368.

Hraun in Fljót [O. D.]. — On leaves of Stellaria sp.

Mucedineae-Amerosporae.

Tubercularia Tode.

794. **T. vulgaris** Tode, Saccardo, Syll. fung. IV, p. 638.

A garden in Reykjavík [P. L.], det. O. Rostrup. — On Prunus padus.

Illosporium Mart.

795. **I. corallinum** Robert, Saccardo, Syll. fung. IV, p. 657.

Hálsskógur [O. D.]. — On the thallus of Peltigera.

Volutella Tode.

796. **V. ciliata** (Albertini et Schweinitz) Fries, Saccardo, Syll. fung. III, p. 467.

Hof [O. D.]; Seyðisfjörður [P. L.]. — On sheep dung and on rotten potatoes.

Mucedineae-Phragmosporae.

Fusarium Link.

797. **F. Kühnii** (Fuckel) Saccardo, Syll. fung. IV, p. 714.

Hof [O. D.]. — Common on moss protonema.

798. **F. Solani** (Mart.) Saccardo, Syll. fung. IV, p. 705.

Hof [O. D.]. — On rotting potatoes.

799. **F. larvarum** Fuckel, Saccardo, Syll. fung. IV, p. 709.

Gásir [O. D.]. — On a larva.

Tuberculariaceae-Dematieae.

Epicoccum Link.

800. **E. Davidssonii** Rostrup, Isl. Svampe 1903, p. 324.

Torfastaðahólmi [O. D.]. — On leaves of Geranium silvaticum.

Myrothecium Tode.

801. **M. roridum** Tode, Saccardo, Syll. fung. IV, p. 750.

Lava fields at Reykjahlíð [P. L.], det. O. Rostrup. — On Achillea millefolium.

Epiclinium Fries.

802. **E. atrum** Bonorden, Handbuch der allgemeinen Mykologie II. Stuttgart 1851, p. 96, t. I, fig. 13. — Saccardo, Syll. fung. IV, p. 755.

Möðruvellir [O. D.]. — On wood.

HOST INDEX.

Laminaria digitata
Dothidella Laminariae
Laminaria saccharina
Dothidella Laminariae
Alaria esculenta
Dothidella Laminariae

Boletus scaber
Hypomyces chrysospermus
Bovista nigrescens
Cladosporium lycoperdinum

Stereocaulon paschale
Scutula Stereocaulorum
Solorina crocea
Bertia lichenicola
Peltigera canina
Illosporium corallinum
Lecanora sordida
Celidium varians
Aspicilia gibbosa
Tichothecium pygmaeum
Parmelia saxatilis
Abrothallus Parmeliarum

Tetraplodon bryoides
Phoma muscorum

Cystopteris fragilis
Hyalospora Polypodii
Dryopteris pulchella
Gloeosporium filicinum
Dryopteris sp.
Mycosphaerella Filicum
Equisetum palustre
Stamnaria Equiseti
Phoma Equiseti
Staganospora Equiseti

Equisetum variegatum
Leptosphaeria Equiseti
Equisetum sp.
Pyrenophora chrysospora
Mycosphaerella Equiseti
Helotium rhodoleucum
Lycopodium selago
Leptosphaeria Marcyensis
Mycosphaerella lycopodina
Lycopodium annotium
Phoma Lycopodii
Selaginella spinulosa
Cladosporium herbarum

Pinus montana
Lophodermium Pinastri
Juniperus nana
Melanomma juniperinum
Lophiostoma Juniperi
Lophodermium juniperinum
Juniperus communis
Herpotrichia nigra

Triglochin maritima
Pleospora Triglochinis
Triglochin palustris
Mycosphaerella Juncaginearum
Anthoxanthum odoratum
Lamproderma violaceum
Pyrenophora phaeocomes
Pleospora herbarum
Leptosphaeria culmicola
Lophodermium arundinaceum
Puccinia Anthoxanthi
P. borealis
Hierochloë borealis
Mycosphaerella recutita
Lophodermium arundinaceum

Puccinia borealis
Mastigosporium album

Phleum alpinum
Lachnum patens

Phleum pratense
Mycosphaerella pusilla
Lachnum patens
Scolecotrichum graminis

Milium effusum
Leptosphaeria culmifraga
L. culmicola

Alopecurus pratensis
Claviceps microcephala

Alopecurus geniculatus
Scolecotrichum graminis

Agrostis canina
Pleospora punctiformis
Leptosphaeria microscopica
Phyllachora graminis

Agrostis alba
Pleospora herbarum
Hadrotrichum virescens

Agrostis vulgaris
Phyllachora graminis
Puccinia borealis
Typhula graminum
Mastigosporium album

Calamagrostis stricta
Leptosphaeria arundinacea
L. Fuckelii
Lophodermium arundinaceum
Myiocopron calamagrostidis
Puccinia borealis
Tilletia striiformis

Deschampsia caespitosa
Lamproderma physaroides
Pleospora vagans var. Airae
Leptosphaeria culmifraga
L. Fuckelii
L. culmicola
Dilophia graminis
Uromyces Dactylidis
Puccinia borealis
Uredo Airae
Entyloma crastophilum
Stagonospora graminella

Deschampsia flexuosa
Pleospora Karstenii

Trisetum spicatum
Pleospora straminis
P. islandica
P. pentamera
Physalospora montana
Belonidium rufum

Trisetum subspicatum
Pleospora Karstenii
Lophodermium arundinaceum
Cladosporium graminum

Catabrosa aquatica
Entyloma Catabrosae

Poa annua
Entyloma irregulare

Poa alpina
Leptosphaeria culmifraga
L. microscopica
L. culmicola
Lophodermium arundinaceum
Uromyces Dactylidis
Puccinia Poarum
Hendersonia silvatica
Septoria graminum
Cladosporium graminum

Poa caesia
Pleospora islandica
P. pentamera
Leptosphaeria culmifraga
Guignardia graminicola
Phyllachora Poae
Lophodermium arundinaceum
Cladosporium graminum

Poa nemoralis
Leptosphaeria culmifraga
Lophodermium arundinaceum
Lachnum patens

Poa pratensis
Claviceps microcephala
Uromyces Dactylidis
Puccinia Poarum
Tilletia striiformis
Staganospora graminella

Glyceria distans
Pleospora pentamera
Scolecotrichum graminis

Festuca ovina
Pyrenophora chrysospora
Lophodermium arundinaceum
Cladosporium graminum

Festuca rubra
Claviceps purpurea
Mycosphaerella recutita
Physalospora Festucae
Lophodermium arundinaceum
Uromyces Festucae
Cladosporium graminum

Nardus strictus
Lophodermium arundinaceum
Godronia pusiola

Agropyrum violaceum
Typhula graminum
Scolecotrichum graminis

Agropyrum caninum
Pleospora islandica
Leptosphaeria nigrans
Mycosphaerella recutita

Elymus arenarius
Pleospora microspora
P. vagans
P. gigaspora
P. herbarum
Leptosphaeria culmifraga
L. Elymi
Lophodermium arundinaceum
L. arundinaceum var. alpinum
Phyllosticta Elymi
Staganospora curvula
Hendersonia arundinacea
Rhabdospora curva
Cladosporium perpusillum
Macrosporium commune

Hordeum vulgare
Ustilago Hordei

Graminaceae spp.
Erysiphe graminis
Mycosphaerella lineolata
Stagonospora islandica

Eriophorum angustifolium
Lophodermium caricinum
Mollisia advena
Erinella callimorpha

Eriophorum Scheuchzerii
Pleospora discors
Sclerotinia Vahliana

Scirpus caespitosus
Mycosphaerella perexigua
Cintractia Caricis

Heleocharis palustris
Physoderma Heleocharidis
Pleospora scirpicola
Stagonospora aquatica

Cobresia scirpina
Leptosphaeria culmifraga
Lophodermium caricinum
Naevia ignobilis
Cintractia Caricis
Septoria punctoidea
Goniosporium puccinioides
Cladosporium caricicola

Carex dioeca
Cintractia Caricis

Carex nardina
Septoria Caricis

Carex capitata
Naevia diminuens

Carex rupestris
Mycosphaerella Wichuriana

Carex chordorrhiza
Mycosphaerella pusilla
M. Wichuriana

Carex stellulata
Cintractia Caricis

Carex lagopina
Metasphaeria culmifida
Mycosphaerella Wichuriana
Leptostroma caricinum

Carex festiva
Lophodermium caricinum

Carex salina
Ophiobolus herpotrichus
Urocystis Fischeri

Carex rigida
Metasphaeria macrotheca
Mycosphaerella Wichuriana
Naevia atrosanguinea
N. diminuens
N. ignobilis
N. fuscella
Cintractia Caricis
Typhula graminum
Leptostroma caricinum
Goniosporium puccinioides
Cladosporium caricicola

Carex hyperborea
Naevia fuscella
Hendersonia Stefanssonii

Carex pulla
Naevia fuscella

Carex Goodenoughii
Mycosphaerella Wichuriana
Naevia atrosanguinea
N. fuscella
Puccinia Caricis
Cintractia Caricis
Leptostroma caricinum

Carex alpina
Leptostroma caricinum

Carex atrata
Naevia diminuens
N. ignobilis
Puccinia Caricis
Cintractia Caricis
Hendersonia Caricis

Carex capillaris
Didymella proximella
Lophodermium caricinum
Cintractia Caricis

Carex panicea
Cintractia Caricis

Carex vaginata
Naevia ignobilis
Septoria Caricis

Carex rostrata
Naevia ignobilis

Carex sp.
Puccinia Caricis
P. uliginosa
Tilletia arctica
Leptostroma caricinum

Juncus balticus
Pleospora pentamera
P. Junci
P. Elynae
Naevia pusilla
Belonidium junciccdum
B. Laschii
Dasyscypha diminuta
Tolyposporium Junci
Arthrinium bicorne

Juncus arcticus
Cladosporium herbarum

Juncus filiformis
Naevia pusilla

Juncus triglumis
Pleospora Spartii
P. Elynae
Leptosphaeria Apogon

Juncus biglumis
Leptosphaeria juncina
Mycosphaerella perexigua

Juncus trifidus
Lachnum calycioides
Arthrinium bicorne

Luzula arcuata
Leptosphaeria Luzulae
Naevia diminuens

Luzula multiflora
Pyrenophora hispidula
Pleospora vagans
Naevia pusilla
Cintractia Luzulae
Vermicularia Liliacearum

Luzula spicata
Pleospora Junci var. Luzulae
Ascochyta tereliuscula

Tofieldia borealis
Pyrenophora chrysospora
Pleospora vulgaris
P. herbarum
Leptosphaeria oreophila
Phoma Tofieldiae

Paris quadrifolia
Cercospora Paridis

Coeloglossum viride
Septoria Orchidearum

Iris germanica
Phyllosticta Pseudacori

Salix herbacea
Mycosphaerella salicicola
Venturia chlorospora
Gnomonia pleurostyla
Rhytisma salicinum
Cryptomyces maximus
Melampsora arctica
Discosia Artocreas

Salix glauca
Ophiobolus salicinus
Venturia chlorospora
Hypospila groenlandica
Linospora Capreae

Lophodermium maculare
Rhytisma salicinum
Melampsora arctica
Septoria salicella
Leptostroma punctiforme
Excipula sphaeroides

Salix phylicifolia
Nectria Coryli
Strickeria Kochii
S. salina
Venturia chlorospora
Linospora caudata
Diaporthe salicella
Lophodermium versicolor
Rhytisma salicinum
Tympanis saligna
Melampsora arctica
Crepidotus citrinus
Phoma salicina
Aposphaeria pulviuscula
Asteroma Salicis
A. Capreae
Cytospora Salicis
Myxosporium salicinum

Salix lanata
Amphisphaeria papillata
Strickeria Davidssonii
Mycosphaerella Capronii
Venturia chlorospora
Linospora Capreae
L. insularis
Fenestella princeps
Diatrype bullata
Rhytisma salicinum
Lachnella corticalis
Lachnum niveum
Helotium virgultorum
Melampsora arctica
Septoria salicella
S. Capreae

Salix sp.
Vermicularia trichella
Hendersonia salicina
Septoria salicina
Piggotia atronitens
Hormiscium stilbosporum

Populus tremula
Steganosporium traphinum

Alnus glutinosa
Phoma endoleuca

Betula pubescens
Enteridium olivaceum
Comatricha nigra
Taphrina betulina
T. carnea
Nectria coccinea
N. Peziza
Leptospora ovina
Lasiosphaeria sorbina var. radiata
Rossellinia mammiformis
R. subcorticalis
Zignoella ovoidea
Melanomma Pulvis pyrius
M. Aspegrenii
Strickeria obducens f. betulina
Mycosphaerella maculiformis
Venturia ditricha
Gnomonia campylostyla
G. setacea
Valsa betulina
V. polyspora
Diaporthe aristata
Fenestella tumida
Cryptospora Betulae
Valsaria Niesslii
Melanconis stilbostoma
Pseudovalsa lanciformis
Diatrypella verrucaeformis
D. favacea
Calosphaeria ciliatula
C. pusilla
Hypoxylon fuscum
Dothidella betulina
Lophium dolabriforme
Cryptodiscus pallidus
Propolis faginea
Ocellaria chrysophaea
Agyrium rufum
Patellaria atrata
P. Bagnisiana
Godronia urceolus
Tapesia fusca
Mollisia caesia
M. Schumacheri
Niptera ramealis
Orbilia coccinella
O. auricolor

Lachnella corticalis
Lachnum bicolor
L. virgineum
Helotium citrinum
H. virgultorum
Coryne sarcoides
Melampsora betulina
Exidia repanda
E. alba
Tremella lutescens
Dacryomyces deliquescens
Hydnum argutum
Tomentella ferruginea
Corticium incarnatum
Stereum vorticosum
S. hirsutum
S. rugosum
S. tuberculosum
Radulum orbiculare
Phlebia radiata
Merulius corium
Polyporus croceus
Polystictus hirsutus
Pleurotus applicatus
Cytospora betulina
Cytosporium betulinum
Discosia Artocreas
Melanconium elevatum
M. bicolor
Hormiscium altum
Coniothecium betulinum
C. effusum

Betula nana
Taphrina nana
T. carnea
T. bacteriosperma
Mycosphaerella harthensis
Gnomonia campylostyla
Diaporthe aristata
Dothidella betulina
Tapesia fusca
Septoria betulina
Hormiscium betulinum
Coniothecium betulinum

Ulmus montana
Aposphaeria glomerata
Coniothyrium olivaceum

Urtica dioeca
Phoma Urticae

Rumex domesticus
Sclerotinia Fuckeliana
Phialea cyathoidea
Dendrophoma marchica
Rhabdospora pleosporoides
Ovularia obliqua
Cladosporium herbarum

Rumex acetosa
Pyrenophora chrysospora
P. phaeocomoides
Venturia caulicola
Vermicularia Dematium
Septoria semilunaris
Rhabdospora pleosporoides

Rumex acetosella
Pleospora herbarum
Mycosphaerella Polygonorum
Rhabdospora pleosporoides

Oxyria digyna
Pyrenophora chrysospora
Pleospora vulgaris
Guignardia Oxyriae
Phialea cyathoidea
Puccinia Oxyriae
Ustilago vinosa
Rhabdospora pleosporoides
Chromosporium album
Macrosporium commune

Polygonum viviparum
Mycosphaerella Polygonorum
Rhytisma Bistortae
Puccinia septentrionalis
P. Bistortae
Ustilago Bistortarum
Sphacelotheca Hydropiperis
Rhabdospora pleosporoides
Botrychonema alpestre
Ramularia Bistortae

Polygonum aviculare
Sclerotinia Fuckeliana
Uromyces Polygoni
Ovularia rigidula
Botrytis cinerea

Atriplex patula
Phoma acuta

Montia lamprosperma
Tolysporium Montiae

Cerastium lapponicum
Peronospora Alsinearum

Cerastium arcticum
Pyrenophora chrysospora
Cerastium alpinum
Peronospora Alsinearum
Pyrenophora Androsaces
P. comata
Pleospora herbarum
Mycosphaerella isariphora
Calloria erythrostigmoides
Phialea dolosella
Melampsorella Cerastii
Septoria cerasticola
S. Stellariae
Cerastium caespitosum
Pyrenophora comata
Pleospora herbarum
Fabraea Cerastiorum
Melampsorella Cerastii
Macrosporium commune
Alsine verna
Pleospora herbarum
Mycosphaerella isariphora
Septoria Alsines
Alsine stricta
Pyrenophora chrysospora
Mycosphaerella isariphora
Alsine biflora
Pyrenophora comata
P. chrysospora
Pleospora herbarum
Mycosphaerella isariphora
Alsine rubella
Pleospora herbarum
Honckenya peploides
Phoma herbarum
Arenaria ciliata
Pyrenophora hispida
P. chrysospora
Mycosphaerella isariphora
M. tingens
M. densa
Cladosporium herbarum
Viscaria alpina
Pyrenophora comata
P. chrysospora
Pleospora alpina
Mycosphaerella sibirica
Sclerotinia Fuckeliana
Cladosporium herbarum
Silene vulgaris
Phialea cyathoidea
Silene maritima
Pleospora herbarum
Leptosphaeria Silenes-acaulis
Mycosphaerella sibirica
Silene acaulis
Pyrenophora Androsaces
Leptosphaeria Silenes-acaulis
Mycosphaerella sibirica
Ustilago violacea
Caltha palustris
Physoderma vagans
Aconitum sp.
Phoma tingens
Ranunculus glacialis
Mycosphaerella Tassiana
Mollisia atrata
Ranunculus reptans
Synchytrium aureum
Ranunculus pygmaeus
Mycosphaerella fusispora
Ranunculus acer
Peronospora Ficariae
Mycosphaerella vulgaris
Fabraea Ranunculi
Phialea cyathoidea
Puccinia Blyttianae
Entyloma Ranunculi
Phyllosticta Ranunculorum
Heteropatella cercosperma
Ovularia decipiens
Ramularia aequivoca
Ranunculus repens
Ramularia aequivoca
Thalictrum alpinum
Pyrenophora chrysospora
Pleospora herbarum
Massaria Thalictri
Urocystis sorosporioides
Discosia Artocreas
Papaver radicatum
Leptosphaeria Papaveris
Mycosphaerella arthopyre-
noides
Draba alpina
Pyrenophora Androsaces

Draba incana
Cystopus candidus
Erysiphe communis
Sphaerotheca humuli
Pyrenospora chrysospora
Mycosphaerella Tassiana
Puccinia Drabae

Draba rupestris
Pleospora Drabae
Mollisia cinerea
Puccinia Drabae

Draba nivalis
Pyrenophora chrysospora
Pleospora herbarum
P. Drabae
Mycosphaerella Tassiana

Cochlearia officinalis
Macrosporium commune

Capsella bursa pastorís
Cystopus candidus
Peronospora parasitica
Phoma herbarum

Arabis alpina
Peronophora chrysospora
Metasphaeria Arabidis
M. islandica

Arabis petraea
Pyrenophora hispida
P. chrysospora
Pleospora herbarum
Metasphaeria Arabidis
Mycosphaerella Tassiana
Heteropatella cercosperma

Cardamine pratensis
Peronospora parasitica
Mycosphaerella Cruciferarum
Puccinia Cruciferarum

Cardamine hirsuta
Cystopus candidus

Cardamine bellidifolia
Cystopus candidus
Pyrenophora chrysospora
Pleospora herbarum
Cladosporium herbarum

Erysimum sp.
Phoma oleraceum

Rhodiola rosea
Pleospora deflectens
Mycosphaerella Tassiana
Dothidella thoracella
Schizoxylon Berkeleyanum
Macrosporium commune

Sedum villosum
Pyrenophora chrysospora
Diaporthe muralis
Sclerotinia Fuckeliana

Sedum annuum
Pyrenophora chrysospora

Saxifraga oppositifolia
Pyrenophora chrysospora
Pleospora herbarum
Mycosphaerella Tassiana
Didymella inconspicua
Melampsora Saxifragarum
Exobasidium Warmingii

Saxifraga stellaris
Puccinia Saxifragae

Saxifraga nivalis
Sclerotinia Fuckeliana
Puccinia Saxifragae
Phoma Saxifragarum

Saxifraga aizoides
Pyrenophora chrysospora var. polaris
Melampsora Saxifragarum

Saxifraga hirculus
Mycosphaerella Tassiana

Saxifraga rivularis
Pyrenophora chrysospora

Saxifraga caespitosa
Pyrenophora chrysospora
Pleospora herbarum
Mycosphaerella Tassiana
Melampsora Saxifragarum
Cladosporium herbarum

Saxifraga hypnoides
Synchytrium groenlandicum
Pyrenospora chrysospora
Melampsora Saxifragarum

Parnassia palustris
Mycosphaerella Parnassiae
Puccinia uliginosa
Septoria semilunaris

Ribes rubrum
Plowrigthia ribesia
Leptosphaeria Ribis

Nectria cinnabarina
Phoma ribicola
Phomopsis ribesia

Ribes alpinum
Phoma Malvacei
Hendersonia Ribis alpini

Rubus saxatilis
Pyrenophora chrysospora
Microthyrium Rubi
Phoma ruborum

Rubus idaeus
Pyrenopeziza Rubi

Potentilla Crantzii = P. maculata
Pyrenophora chrysospora
Pleospora vulgaris
P. herbarum
Guignardia Potentillae
Sphaerulina Potentillae
Physalospora Potentillae
Leptostroma Potentillae

Potentilla verna
Mycosphaerella melanoplaca

Potentilla anserina
Marssonina Potentillae

Potentilla palustris
Physoderma vagans
Mycosphaerella Tassiana
Marssonina Potentillae
Septogloeum Fragariae

Sibbaldia procumbens
Trichia contorta
Mycosphaerella innumerella
Lophodermium petiolicolum
Sclerotinia Fuckeliana
Botrytis cinerea

Geum rivale
Sclerotinia Fuckeliana
Rhabdospora pleosporoides
Discosia Artocreas
Botrytis cinerea

Dryas octopetala
Synchytrium cupulatum
Pleospora herbarum
Leptosphaeria Dryadis
Lizonia abscondita
Mycosphaerella ootheca
M. Dryadis
Venturia islandica
Massarina Dryadis
Gnomonia vagans
Hypospila rhytismoides
Septoria semilunaris

Filipendula ulmaria
Triphragmium Ulmariae
Phyllosticta filipendulina

Alchimilla alpina
Pleosphaerulina vitrea
Sclerotinia Fuckeliana
Phoma Alchimillae
Discosia Artocreas
Ovularia alpina
Botrytis vulgaris

Alchimilla vulgaris
Coleroa Alchimillae
Uromyces Alchimillae
Phoma herbarum

Prunus padus
Cytospora leucostoma
Tubercularia vulgaris

Sorbus aucuparia
Dothiora Sorbi
Nectria cinnabarina
Corticium incarnatum
Aposphaeria subtilis
Cytospora Massariana
C. microspora
Rhabdospora inaequalis
Dothichiza Sorbi
Myxosporium Aucupariae

Sorbus suecica
Mollisia melaleuca

Anthyllis vulneraria
Mycosphaerella Vulnerariae

Vicia cracca
Peronospora Viciae
Pyrenophora chrysospora
P. phaeocomoides
Pleospora deflectens
Mycosphaerella Viciae
Phoma melaena
Septoria Viciae

Geranium silvaticum
Leptosphaeria agnita
Metasphaeria complanata
Fabraea confertissima
Sclerotinia Fuckeliana

Cyphella villosa
Septoria semilunaris
Epicoccum Davidssonii

Linum catharticum
Pleospora herbarum
Melampsora Lini

Viola tricolor
Pleospora herbarum
Ramularia lactea

Viola canina
Pucciniae Violae
Ramularia lacteae

Viola palustris
Puccinia Fergussoni

Epilobium lactiflorum
Puccinia Epilobii

Epilobium alsinefolium
Puccinia Epilobii

Epilobium palustre
Melampsora pustulata
Pucciniastrum Epilobii
Puccinia Epilobii
Fusidium punctiforme

Epilobium alpinum
Melampsora pustulata
Puccinia Epilobii

Chamaenerium latifolium
Mycosphaerella Tassiana
Ramularia Chamaenerii

Chamaenerium angustifolium
Ramularia punctiformis

Hippuris vulgaris
Physoderma Hippuridis

Cornus suecica
Leptothyrium vulgare

Carum carvi
Phialea cyathoidea
Leptostroma herbarum
Heteropatella cercosperma

Haloscias scoticum
Puccinia Halosciadis

Angelica silvestris
Metasphaeria Angelicae
Mycosphaerella rubella
Dothidella Angelicae
Heterosphaeria Patella
Phialea cyathoidea
Fusicladium Angelicae

Archangelica officinalis
Leptosphaeria Doliolum
Metasphaeria Angelicae
Dothidella Angelicae
Heterosphaeria Patella
Calloria minutissima
Phialea cyathoidea
Coniothyrium conoideum
Heteropatella cercosperma
Ramularia Archangelicae
Fusicladium Angelicae
Macrosporium commune

Pyrola secunda
Melampsora Pyrolae

Pyrola minor
Melampsora Pyrolae
Chrysomyxa Pyrolae

Loiseleuria procumbens
Mycosphaerella polyspora

Arctostaphylos uva ursi
Asteroma alpinum
Gloeosporium alpinum
Coniosporium melanconideum

Vaccinium uliginosum
Podosphaera myrtillina
Venturia Myrtilli
Lophodermium maculare
Clithris degenerans
Melampsora Vacciniorum
Exobasidium Vaccinii
Diplodina Eurhododendri

Vaccinium Myrtillus
Coccomyces quadratus
Pseudophacidium degenerans
Melampsora Vacciniorum
Exobasidium Vaccinii

Diapensia lapponica
Sphaerulina Diapensiae
Sphaeropeziza Arctostaphyli
Ascochyta Diapensiae

Primula stricta
Pyrenophora chrysospora

Armeria maritima
Pleospora herbarum
Leptosphaeria microscopica
Uromyces Limonii

Solanum tuberosum
Phytophthora infestans
Phoma solanicola
Volutella ciliata
Fusarium Solani

Veronica serpyllifolia
Peronospora grisea

Veronica alpina
Pyrenophora chrysospora
Guignardia Veronicae
Puccinia Veronicarum

Veronica saxatilis
Pyrenophora chrysospora
Ascochyta Veronicae

Veronica Anagallis
Synchytrium globosum

Euphrasia latifolia
Pyrenophora chrysospora
Phoma herbarum
Rhabdospora eupyrenoides

Bartsia alpina
Pyrenophora chrysospora
Mollisia atrata
Phoma Sceptri
P. herbarum
Placosphaeria Bartsiae
Ramularia Bartsiae

Alectorolophus crista galli
Plasmopara densa
Pyrenophora chrysospora
P. abscondita
Scleroderris aggregata
Phoma complanata
Ph. deusta

Pedicularis flammea
Pyrenophora Androsaces
Slerotinia Fuckeliana
Phoma Sceptri

Plantago major
Peronospora alta

Plantago maritima
Pyrenophora chrysospora
Septoria semilunaris

Myosotis arvensis
Erysiphe Cichoriacearum

Thymus serpyllum
Pleospora vulgaris
P. herbarum
Mycosphaerella Tassiana
Puccinia Schneideri
Phoma herbarum

Gentiana nivalis
Pyrenophora chrysospora
Mycosphaerella Gentianae

Gentiana campestris
Pyrenophora chrysospora
Sclerotinia Fuckeliana

Gentiana amarella
Mycosphaerella Tassiana

Menyanthes trifoliata
Physoderma Menyanthis

Campanula uniflora
Pleospora herbarum

Campanula rotundifolia
Coleosporium Campanulae

Galium pumilum
Pleospora herbarum
Puccinia punctata
Stagonospora Galii

Galium verum
Peronospora calotheca
Mazzantia Galii
Placosphaeria Galii
Septoria Galiorum

Galium boreale
Peronospora calotheca
Phacidium repandum

Cirsium arvense
Pleospora herbarum
Mycosphaerella Compositarum

Erigeron alpinus
Pyrenophora chrysospora
Pleospora herbarum
Mycosphaerella eriophila
Guignardia lunulata
Septoria semilunaris

Erigeron neglectus
Pyrenophora chrysospora

Gnaphalium norvegicum
Mycosphaerella Compositarum
Sclerotinia Fuckeliana
Helotium scutula
Phialea cyathoidea
Heteropatella cercosperma
Ramularia filaris

Achillea millefolium
Pyrenophora phaeocomoides
P. coronata
Ophiobolus Cesatianus

Matricaria inodora
Phoma herbarum
Cladosporium herbarum

Leontodon autumnalis
Puccinia Leontodontis

Taraxacum vulgare
Protomyces pachydermus
Sphaerotheca humuli
Pyrenophora chrysospora
Mycosphaerella Taraxaci
Puccinia variabilis
Ramularia Taraxaci

Taraxacum croceum
Puccinia silvatica

Crepis paludosa
Physoderma Crepidis

Hieracium alpinum
Puccinia Hieracii
Heteropatella cercosperma

Hieracium prenanthoides
Mollisia atrata

Hieracium murorum
Puccinia Hieracii
Entyloma Calendulae
Botrytis cinerea

Hieracium islandica
Pyrenophora chrysospora
Pleospora islandica
P. vulgaris
Puccinia Hieracii

Hieracium sp.
Erysiphe Cichoriacearum
Pyrenophora chrysospora
Pleospora herbarum
Leptosphaeria ogilviensis
L. agnita
Mycosphaerella Hieracii
Sclerotinia Fuckeliana

APPENDIX.

Mr. Aage Lund has sent me a list of fungi from Iceland collected by Mr. L. Harmsen and Mr. St. Steindórsson. As I have received the list at a moment when a great part of the present paper was printed, I give the list here as an appendix.

105. **Metasphaeria islandica** (Rostr.) P. Larsen.
Langarvatnsfjall [Harmsen].

264. **Lophodermium arundinaceum** [Schrad.) Chev.
Reykholt [H.]. — On Agrostis tenuis.

396. **Puccinia Poarum** Niels.
Kristnes [Steindórsson].

404. **Puccinia Drabae** Rudolphi.
Isafjörður [H.].

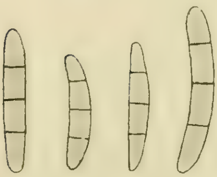


Fig. 20. *Hendersonia Violæ.* Conidia. × 800.

Hendersonia Violæ A. Lund, n. sp.

Pycnidiis globosis, gregariis, in macula albida dispositis, primitus epidermide tectis dein erumpentibus, 64—84 μ diam. Conidiis oblongis, rectis vel curvulis, ad sepimentis non constrictis, primo 1-septatis, dein 2-septatis, denique 3-septatis, pallide fuligineis, 20—27,5 μ × 3—4 μ. In foliis Violæ palustris ad Reykjadalur. Aug. 1931 (leg. L. Harmsen).

Hendersonia triceptata Da Camara (Saccardo, Sylloge, Vol. 12, p. 1060), which occurs on Viola alba, has also conidia with 3 transverse septa, but the conidia are much shorter (12—15 μ) than in *H. Violæ* and they are never curved.

Sclerotlum rhizodes Auersw.
Reykholt [H.]. — On Agrostis tenuis.

CORRIGENDA.

Page 460, l. 5 from bottom, for endolenca read endoleuca.
— 467, l. 10 from top, for Johansson read Johanson.
— 468, l. 1 from top, for Cichoracearum read Cichoriacearum.
— 478, l. 11 from bottom, for 860 read 680.
— 496, l. 8 and 9 from bottom, for Roberge read Robert.
— 498, l. 3 from top, for 41 read 32.
— 502, l. 1—3 mnst be omitted (= No 244, page 413).
— 508, l. 8 and 9 from bottom, for Kerveni read Kerverni.
— 518, l. 14 from top, for 1847 read 1817.
— 568, l. 13 from top, for Nat. read Mat.

LITTERATURE.

1814. **Acharius, E.,** Synopsis methodica Lichenum. Lundae.

1805. **Albertini, J. B. de,** et **Schweinitz, L. D. de,** Conspectus fungorum in Lusatiae superioris agro Niskiensi crescentium e methodo Persooniana. Lipsiae.

1896. **Allescher, A.,** Berichte d. Bayer. Bot. Gesellsch., vol. IV, p. 36.

1897. — Pilze aus dem Umanakdistrikt. Bibliotheca Botanica, Heft 42, pp. 40—54. Stuttgart.

1862. **Arnold, F. C. G.,** Flora, p. 312.

1866. **Auerswald,** Leipziger Bot. Tausch-Verein, p. 4.

1870. — in Rabenhorst Mycologia Europaea. Heft V und VI. Dresden.

1884. **Bary, A. de,** Vergleichende Morphologie und Physiologie der Pilze, Mycetozoen und Bakterien. Leipzig.

1783—1789. **Batsch. Aug.,** Elenchus fungorum. Halae, 1783. Continuatio I. ibid., 1786, II. ibid., 1789.

1836. **Berkeley, J. M.,** British Fungi in J. E. Smith: English Botany V, part II.

1838—1889. — et **Broome C. E.,** Notices of British Fungi, No. 1—2050, in Annals and Magazine of Natural History, 1838—1889.

1860. — Outlines of British Fungology, Landres.

1872. — and **Ravenel, H. W.,** in Notices of North American Fungi, by M. J. Berkeley, in Grevillea I.

1888. **Berlese, A. N.,** Monografia dei generi Pleospora, Clathrospora e Pyrenophora. Firenze.

1851. **Bonorden, H. P.,** Handbuch der allgemeinen Mycologie als Anleitung zum Studium derselben, nebst speciellen Beiträge zur Vervollkommnung dieses Zweiges der Naturkunde. Stuttgart.

1869. **Boudier, Ém.,** Mémoire sur les Ascobolés. Paris. Annales des sciences naturelles, 5. Série, Vol. I.

1885. — Description de quelques espèces nouvelles de champignons basidiosporés. (Bull. Soc. Botan. de France, Paris 1885).

1904—1910. — Icones mycologicae ou Iconographie des champignons de France principalement Discomycètes. Paris.

1881—1900. **Bresadola, J.,** Fungi Tridentini novi vel nondum delineati, descripti et iconibus illustrati. 2 vol. Tridentini.

1930. — Iconographia Mycologica, vol. XV. and vol. XVI, Milano.

1780—1798. **Bulliard, P.,** Herbier de la France ou collection complète des plantes indigènes de ce royaume — 603 pl. Paris.

1791—1798. — Histoire des champignons de la France. 111 pl. Paris.

1863. **Cesati, V. de,** et **Notaris, G. de.** Schema di classificazione degli Sferiacei Italici aschigeri (Comment. Soc. crittog. Ital. vol. I). Genova.

1836. **Chevallier, P.,** Flore générale des environs de Paris. Ed. 2. Paris.

1866. **Cooke, M. C.**, Journal of Botany, p. 245.
1883. — in Grevillea, p. 32.
1887. — et **Massee, G.**, in Grevillea XV, p. 111.
1837—1854. **Corda, A. C. J.**, Icones Fungorum hucusque cognitorum. Pragae.
1794. **Davies, H.**, Trans. Linn. Soc. II, p. 284.
1815. **De Candolle, A. P.**, et **Lamarck, J. D.**, Flore française, vol. 5. Paris.
Desmazières J. B. H. J., in Annales des sciences naturelles. Botanique. Paris.
1840. — Série II, vol. 13, p. 187.
1843. — Série II, vol. 19, p. 351 og p. 358.
1851. — Série III, vol. 16, p. 313.
1911. **Diedicke, H.**, Annales Mycologici IX, p. 29. Berlin.
— Kryptogamenflora der Mark Brandenburg, Vol. IX, p. 198.
1846—1849. **Durieu de Maisonneuve, Ch.**, et **Léveillé, J.**, Flore d'Algérie: Cryptogamie. Paris. (Fungi par Léveillé).
1819. **Ehrenberg, Ch. G.**, Jahrbücher des Gewächskunde, hierausgegeben von Sprengel, Schrader und Link. Vol. I, Heft 2.
1878. — Sylvae mycologicae berolinenses. Berlin.
1882. **Ellis J. B.**, in Bull. Torrey Bot. Club, IX.
1879—1896. **Fautrey, F.**, in Revue Mycologique.
1863. **Fresenius, G.**, Beitrage zur Mykologie. Frankfurt a. M.
1815—1818. **Fries, Elias M.**, Observationes mycologicae, praecipue ad illustrandam Floram suecicam, 2 partes. Havniae.
1819. — Vetensk. Akad. Handl., p. 104.
1821—1832. — Systema mycologicum, sistens fungorum ordines, genera et species hucusque cognitae, quas ad normam methodi naturalis determinavit, disposuit atque descripsit. Gryphiswaldiae (vol. I, 1821 — vol. II, 1822—23 — vol. III, 1829—32).
1828. — Elenchus fungorum, sistens commentarium in systema mycologicum. Gryphiswaldiae.
1836—1838. — Epicrisis systematis mycologici, Upsaliae et Lundae, 1836—38.
1849. — Summa vegetabilium scandinaviae II. Upsaliae.
1874. — Hymenomycetes Europaei. Upsaliae.
1873—1874. **Fuckel, L.**, Symbolae mycologicae. Beiträge zur Kenntniss der reinischen Pilze. II. Nachtrag. — Jahrbücher d. Nassauischen Vereins f. Naturkunde, vol. 27—28. Wiesbaden.
1874. **Gillet, C. C.**, Les Hyménomycètes ou description de tous les champignons qui croissent en France. Alençon.
1889—1892. — Champignons de France. Les Discomycètes. Alençon.
1791. **Gmelin, C. Ch.**, in Linné, Systema naturae. Ed. XIII. II.
1823—1828. **Greville R. K.**, Scottish cryptogamic Flora or coloured figures and descriptiones of cryptogamic plants found in Scotland. Edinburgh.
1876. **Hansen, Emil, Chr.**, De danske Gødningssvampe. Fungi fimicoli danici. — Vid. Meddelelser fra Nat. For., pp. 207—354. København.
1801. **Hedwig, J.**, Species muscorum frondosum. 1801.
1790. **Hoffmann, G. F.**, Vegetabilia cryptogama II. Erlangae.

1790. **Holmskiold, Th.,** Beata ruris otia fungis danicis impensa, vol. I. Havniae.
1903. **Höhnel, F. von,** Mycologische Fragmente. Annales Mycologici I, pp. 391—414. Berlin.
1907. **Jaap, O.,** Schriften der Nat. Verein f. Schleswig-Holstein, Vol. XIV, Hft. I.
1884. **Johanson, C. J.,** Svampar från Island. Öfversigt af Kgl. Vetenskaps-Akademiens Förhandlingar 1884. Nr. 9. Stockholm.
1885. — Bihang t. Vetenskaps-Akademiens Förhandlingar, p. 34 og p. 43. Stockholm.
1887. — Stud. öfver svampslägtet Taphrina. Bihang t. k. sv. Vet. Akad. Hand. Bd. 13.
1895. **Juel, H. O.,** in Öfversigt af Kgl. Vetenskaps-Akademiens Förhandlingar 52, p. 383.
1871—1876. **Karsten, P. A.,** Mycologia Fennica I—III. Helsingfors I. 1871 — II. 1873 — III. 1876.
1872. — Fungi in insulis Spetsbergen et Beeren Eiland collecti. Öfversigt af Kgl. Vetenskaps-Akademiens Förhandlingar 1872, No. 2, pp. 91—108. Stockholm.
1879—1882. — Rysslands, Finlands och den Scandinaviska halföns Hattsvampar (Agaricinae). Helsingfors.
1884. — Fragmenta mycologica in Hedwigia.
1885. — Revisio monographica atque synopsis Ascomycetorum in Fennia hucusque detectorum. Act. Soc. pro Fauna et Flora Fennic. Helsingfors.
1867. **Kickx, J.,** Flore cryptogamique des Flandres, 2 vol., Gand et Paris.
1924. **Konrad, P.,** et **Maublanc, A.,** Icones selecta Fungorum. Fascicule 2. Paris.
1817—1823. **Kunze, G.,** et **Schmidt, J. K.,** Mykologische Hefte. — 2 voll. Leipzig.
1865. **Körber, G. W.,** Parerga lichenologica, p. 467. Breslau.
1914—1930. **Lange, Jakob E.,** Studies in the Agarics of Denmark (in Dansk Botanisk Arkiv 1914—1930).
1914. Part I Mycena .... Dansk Bot. Arkiv vol, 1, No. 5.
1915. — II Amanita. Lepiota. Coprinus. — — — — 2, — 3.
1917. — III Pluteus. Collybia. Inocybe. — — — — 2, — 7.
1921. — IV Pholiota. Marasmius. Rhodophyllus .... — — — — 2, — 11.
1923. — V Ecologial Notes. The Hygrophori. Stropharia and Hypholoma .... — — — — 4, — 4.
1926. — VI Psalliota. Russula ...... — — — — 4, — 12.
1928. — VII Volvaria. Flammula. Lactarius .... — — — — 5, — 5.
1930. — VIII Omphalia. Pleurotus. Clitocybe............. — — — — 6, — 5.
1828—1829. **Lasch, W. G.,** Enumeratio Agaricorum Marchiae Brandenburgicae. — In Linnaea III.
1857. — in Botanische Zeitung, p. 428.
1908. **Lind, J.,** Sur le développement et la classification de quelques espèces de Gloeosporium. — Arkiv för Botanik, vol. 7, No. 8. Stockholm.

1913. **Lind, J.,** Danish Fungi as represented in the herbar. of E. Rostrup. Copenhagen.
1926. — Micromycetes from North-Western Greenland. Meddelelser om Grønland 71, p. 174.
1927. — The geographical distribution of some arctic Micromycetes. — Det Kgl. Danske Videnskabernes Selskab. Biologiske Meddelelser. VI, 5. København.
1928. — The Micromycetes of Svalbard. — Skrifter om Svalbard og Ishavet, No. 13. Oslo.
1928. — Micromyceter fra Åreskutan. — Svensk Botanisk Tidsskrift, vol. 22, H. 1—2. Stockholm.
1817. **Nees von Esenbeck, Ch. G.,** Das System der Pilze und Schwämme. Würzburg.
1877. **Nielsen, P.,** Bemærkninger om nogle Rustarter, navnlig om en genetisk Forbindelse mellem Aecidium Tussilaginis P. og Puccinia Poarum n. sp. — Botanisk Tidsskrift, vol. 10, pp. 26—42. København.
1872. **Niessl, G. von,** Beiträge zur Kenntniss der Pilze.
1875. — in Oesterr. Bot. Zeitschr., p. 128.
1876. — Notizen über neue und kritische Pyrenomyceten. — Verh. naturforsch. Verein Brünn XIV.
1880. — in Hedwigia, Dresden, p. 173.
1882. — in Oesterr. bot. Zeitschr., No. 11.
1867 og 1871. **Nitschke, Th.,** Pyrenomycetes Germanici. — Die Kernpilze Deutschlands. Breslau, Lief. I, 1867, Lief. II, 1870.
1861. **Notaris, G. de,** in Commentaria della Societa crittogamica Italiana vol. II. Genova.
1873. **Oudemanns, C. A.,** Matériaux pour la flore mycologique de la Néerlande. Archiv. Néerland. vol. VIII.
1884. — Nederlandsch Kruidkundig Archief. Serie 2, vol. IV.
1885. — Contributions a la flore mycologique de Nowaja Semlja. Medd. der Konink. Ak. van. Wet. 3. Recks. Deel II. Amsterdam.
1872—1881. **Passerini, G.,** Fungi Parmensi in Nuovo Giorn. Bot. Ital.
1873. **Peck, C. H.,** in 25. Reports of the St. Botan. New York St. Museum.
1881. — in 33. Reports of the Botan. New York St. Museum.
1791. **Persoon, C. H.,** in Linnaeus' Systema Naturae, 13th edition.
1796—1799. — Observationes mycologicae seu descriptiones tam novorum tam notabilium fungorum. — 2 parties. Leipzig.
1797. Tentamen dispositionis methodicae fungorum in classes, ordines, genera et familias cum supplemento adjecto. Leipzig.
1797. — in Usteri, N. Ann. d. Bot. V.
1798—1800. — Icones et descriptiones cum differentiis specificis. Leipzig.
1801. — Synopsis methodica fungorum. Göttingen.
1822—1828. — Mycologia europaea s. completa omnium fungorum in variis Europae regionibus detectorum enumeratio, methodo naturali disposita, descriptione succincta, synonymia selecta et observationibus criticis additis elaborata. Erlangen.
1925. **Petrak, F.,** Beiträge zur Pilzflora Südost-Galiziens und der Zentralkarpathen. Hedwigia, vol. LXV, pp. 179—330. Dresden.
1874—1885. **Phillips, W.,** et **Plowright, C. B.,** New and rare British Fungi. In Grevillea.

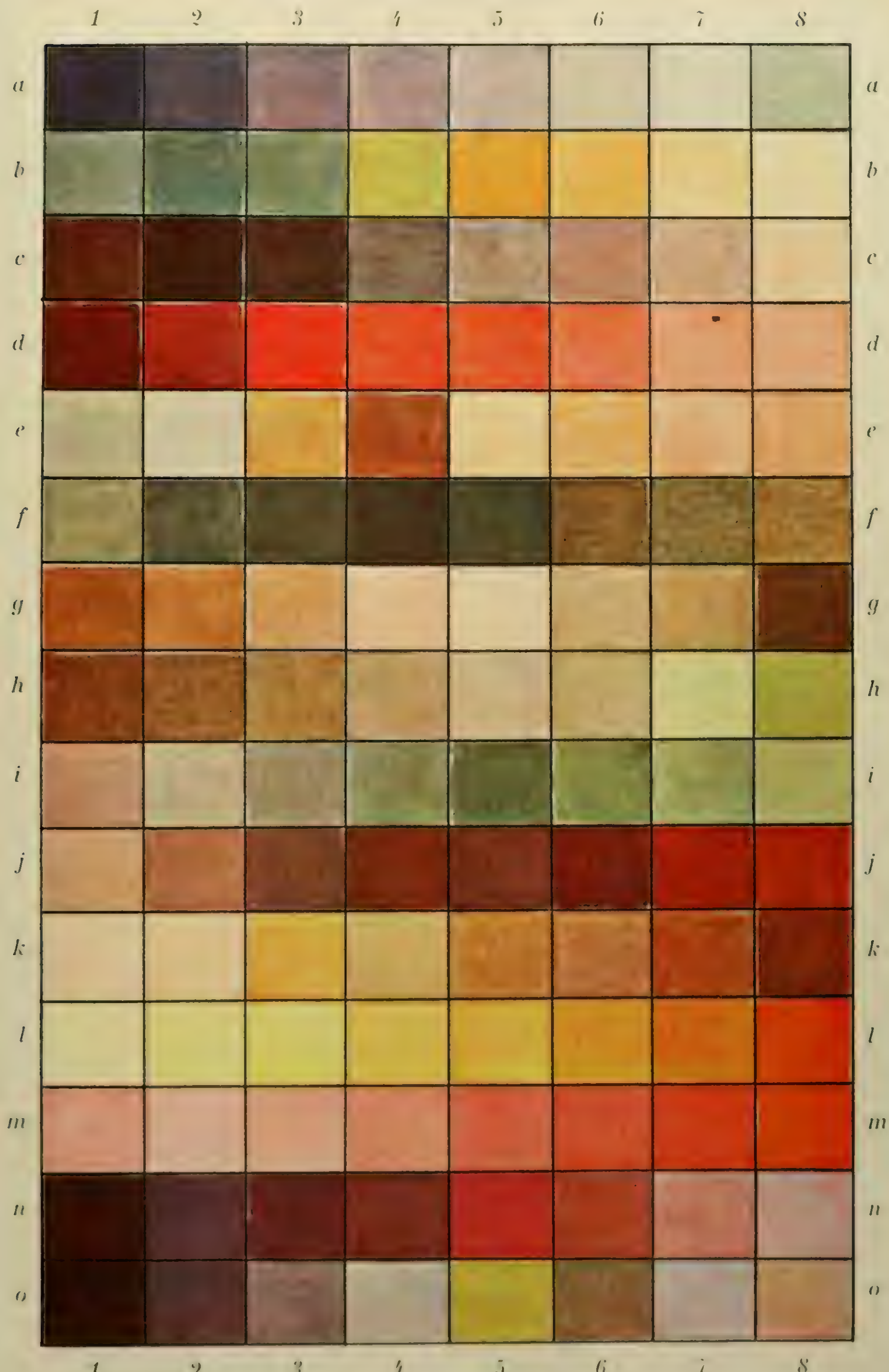
1872—1876. **Quélet, L.,** Les Champignons du Jura et des Vosges (in Mém. de la Soc. d'émulation de Montbéliard I, 1872; II, 1873; III, 1876).
1886. — Enchiridium fungorum in Europa media et præsertim in Gallia vigentium. Paris.
1888. — Flore mycologique de la France et des pays limitrophes. Paris.
1804. **Rebentisch, J. F.,** Prodromus Florae Neomarchicae. Berolini.
1896. **Rehm, H., von,** Ascomyceten, III Abtheilung, Rabenhorst's Kryptogamenflora von Deutschland, Oesterreich und der Schweiz. Zweite Auflage, erster Band. Pilze.
1907. — in Annales Mycologici V, 1907, p. 231.
1915. **Ricken, A.,** Die Blätterpilze (Agaricaceae). Leipzig.
1847 and 1853. **Roberge et Demazières, J. B. H. J.,** i Annales des Sciences Naturelles-Botanique 1847, IIIe serie, vol. VII, p. 185, and 1853, vol. XX, p. 93.
1911. **Romell, L.,** Hymenomycetes of Lappland. — In Arkiv för Botanik, utgifvet af Kgl. Svenska Vetenskaps-Akademien i Stockholm. Vol. 11, No. 3. Stockholm.
1881. **Rostrup, E.,** in v. Thümens: Mycotheca universalis No. 2083.
1881. — Mycologische Notiz. Bot. Centralbl. V, pp. 126—127.
1883. — Mykologiske Notitser fra en Rejse i Sverige i Sommeren 1882. — Öfversigt Kgl. Vet.-Akad. Förhdl. Stockholm 1883 Nr. 4, pp. 35—47.
1883. — Fortsatte Undersøgelser over Snyltesvampenes Angreb paa Skovtræerne. Tids. Skovbrug, vol. 6, pp. 199—300.
1885. — Islands Svampe. — Botanisk Tidsskrift, vol. 14, pp. 218—229. København.
1886. — Svampe fra Finmarken samlede i Juni og Juli 1885 af Professor E. Warming. — Botanisk Tidsskrift, vol. 15, pp. 229—236. København.
1888. — Oversigt over Grønlands Svampe. — Meddelelser om Grønland III, 3, pp. 515—590.
1890. — Ustilagineae Daniae. — Botanisk Forenings Festskrift, pp. 117—168. København.
1891. — Ascomyceter fra Dovre. — Bidrag til Kundskaben om Norges Soparter. II. Kristiania Videnskabs-Selskabs Forhandlinger for 1891. No. 9.
1891. — Tillæg til »Grønlands Svampe (1888)«. — Meddelelser om Grønland III, 3, pp. 591—644.
1894. — Øst-Grønlands Svampe. Meddelelser om Grønland XVIII, pp. 43—81.
1895. — Mykologiske Meddelelser V., Botanisk Tidsskrift, vol. 19, pp. 201—214. København.
1896. — Mykologiske Meddelelser VI, Botanisk Tidsskrift, vol. 20, pp. 126—136. København.
1902. — Plantepatologi. København.
1903. — Islands Svampe. Botanisk Tidsskrift, vol. 25, pp. 281—335. København.
1904. — Vejledning i den danske Flora, II. Del. København.
1882—1926. **Saccardo, P. A.,** Sylloge fungorum omnium hucusque cognitorum. Patavi, 24 volumes.

1900. **Salmon, E. S.,** A monograph of the Erysiphaceae. New York.
1800. **Schaeffer, J.,** Fungorum qui in Bavaria et Palatinatu circa Ratisbonam nascuntur icones. 2. édition revue par C. H. Persoon, 5 vol. Erlangen.
1852. **Schlechtendal, F. L. de,** in Botanische Zeitung, p. 617.
1881. **Schroeter, J.,** Ein Beitrag zur Kenntniss der nordischen Pilze. 58. Jahresber. der Schl. Gesellsch. für vaterl. Cultur 1880. Breslau.
1888. — Beiträge zur Kenntniss der nordischen Pilze. Jahresber. der Schles. Gesellsch. für vaterl. Cultur. 1887, p. 266. Breslau.
1889. — Die Pilze Schlesiens I. — Cohn's Kryptogamenflora von Schlesien. Vol. 3, Pilze I. Breslau.
1908. — Die Pilze Schlesiens, II. — Cohn's Kryptogamenflora von Schlesien. Vol. III, Pilze II. Breslau.
1803. **Schumacher, C. F.,** Enumeratio Plantarum in partibus Sællandiæ septentrionalis et orientalis. Pars posterior (Cryptogamæ). Hafniæ.
1760 and 1772. **Scopoli, J. A.,** Flora Carniolica exhibens plantas Carniolae indigenas et distributas in classas naturales cum differentiis specificis, synonymis recentiorum etc. — 1760 2. editio, 2 voll. Vindobonae.
1833. **Secrétan, L.,** Mycographie suisse ou description des champignons qui croissent en Suisse, particulièrement dans le canton de Vaux, aux environs de Lausanne. 3 voll. Genève.
1826. **Sommerfelt, S. Chr.,** Supplementum Florae Lapponicae quam edit. S. Wahlenberg. Christiania.
1797—1805. **Sowerby, J.,** Coloured figures of English Fungí or Mushrooms. — London (Davis), 3 voll. et suppl., 440 pl.
1904. **Sydow, H. et P.,** Monographia Uredinearum. Vol. I, Puccinia. Lipsiae.
1887. **Thomas, Fr.,** Botanisches Centralblatt XXIX, Jena, p. 19.
1878. **Thümen, F. von,** Beiträge zur Pilz-Flora Sibir. No 766 (Bulletin de la Soc. Impér. des naturalistes de Moscou).
1790—1791. **Tode, H. G.,** Fungi Mecklenburgenses selecti, Lüneburgi.
1852. **Tulasne, L. R.,** Mém. lich. in Ann. sc. Nat. sér. III, vol. XVII. Paris.
1860. — et **Ch.** Ann. des sc. Nat., sér. IV, vol. XIII, p. 16.
1861—1865. — Selecta fungorum Carpologia. Paris, vol. I, 1861; vol. II, 1863; vol. III 1865.
1812. **Wahlenberg, G.,** Flora lapponica. Berlin.
1833. **Wallroth, K. F. W.,** Flora cryptogamica Germaniae II. Norimbergae.
1842—1844. — Beiträge zur Botanik. Leipzig.
1861. **Westendorp G. D.,** in Bulletin Academie Royale de Botanique, II. série, vol. XI, No. 6. Bruxelles.
1872. **Winter, G.,** Hedwigia, p. 149.
1873. — Die deutschen Sordarien. (Abhandl. d. Naturf. Gesellschaft zu Halle. Vol. XIII. Halle).
1887. — Die Pilze Deutschlands, Oesterreichs und der Schweiz. II. Abtheilung. — Dr. L. Rabenhorst's Kryptogamen-Flora, vol. I. Leipzig.
1842. **Vittadini, C.,** Monographia Lycoperdineorum. Torino.
1772. **Zoëga, Johan,** Flora Islandica. Tilhang til Eggert Ólafssons Rejse igennem Island. Sorø.

INDEX.

(SYNONYMS ITALICIZED).

Printing finished February 1932.


1 2 3 4 5 6 7 8
a
b
c
d
e
f
g
h
i
j
k
l
m
n
o
1 2 3 4 5 6 7 8

THE BOTANY
OF
ICELAND

EDITED
BY

L. KOLDERUP ROSENVINGE
PH. D.

AND

EUG. WARMING (†)
PH. D., SC. D.

VOL. II

WITH 6 PLATES AND 73 FIGURES IN THE TEXT

COPENHAGEN
J. FRIMODT

LONDON
HUMPHREY MILFORD
OXFORD UNIVERSITY PRESS

1932

PUBLISHED BY THE AID OF THE CARLSBERG FUND

H. H. THIELES BOGTRYKKERI. KØBENHAVN

CONTENTS

THE BOTANY OF ICELAND

EDITED BY

L. KOLDERUP ROSENVINGE AND EUG. WARMING (†)

PRINTED BY H. H. THIELE. COPENHAGEN